LYNX HARVEST STUDY

1988/1989 Progress Report

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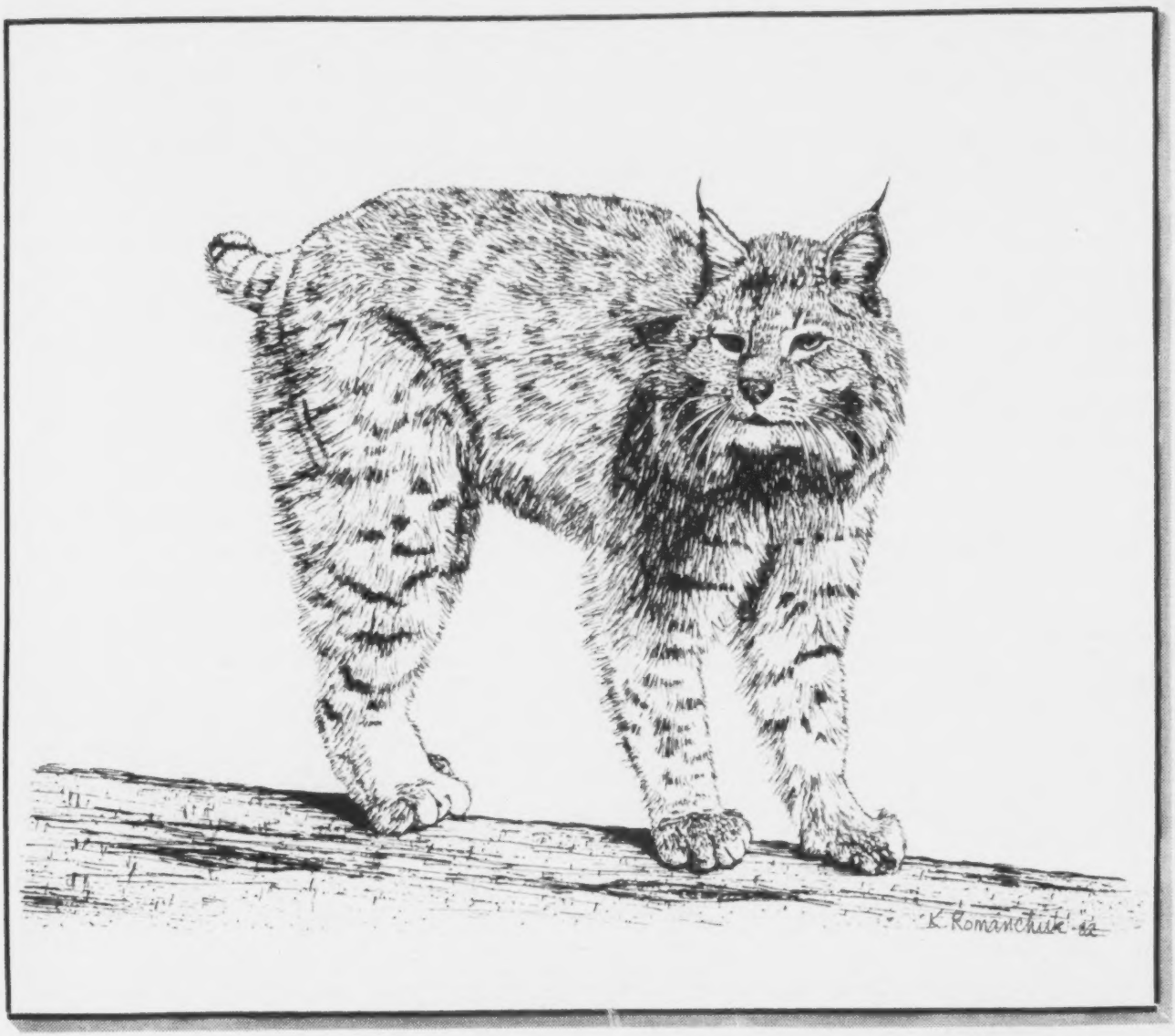

Yukon
Renewable Resources

LYNX HARVEST STUDY

1988/89 Progress Report

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ABSTRACT

The Yukon Fish and Wildlife Branch initiated a study in 1986 to determine the role untrapped areas play in maintaining lynx populations amongst traplines. Population dynamics and movements of lynx are the main parameters of inspection. The degree to which trapping mortality is compensatory for natural mortality in lynx is an unknown, yet significant feature of lynx populations which must be understood in order to define optimal harvest strategies. Evidence for compensation is also being investigated. The results of the study will be ultimately used to simulate lynx population dynamics and project long term management strategies. Techniques for monitoring lynx population densities and recruitment rates are also being developed. The study area is in the southern Yukon, 110 km southeast of Whitehorse.

Lynx are live-captured and radio-collared, except newborn kittens which are only ear-tagged. Population dynamics and movements are subsequently monitored through radio telemetry and recapture. Kitten recruitment is monitored through snow tracking, and lynx density through track observations in combination with known locations of radio-collared individuals. Snowshoe hare populations on the study area are monitored using turd quadrats and winter track-counts.

We also have programs for monitoring Yukon-wide, or regional lynx populations: a trapper harvest calendar to monitor trapper effort and success; a trapper questionnaire to monitor lynx and hare abundance; lynx harvest data; a lynx carcass collection to assess population parameters adjacent to our study area; and lynx pelt measurements to assess recruitment.

The late winter snowshoe hare density increased from an estimated 0.7 hares/ha in 1987 to 1.7 hares/ha in 1989. Greatest densities of 3.0 hares/ha were noted in pine/willow burn regeneration in 1989.

Twenty-four lynx were live-captured 39 times over 3 winters. The use of soft catch leg-holds was discontinued in 1988/89 in favour of foot snares, following an unacceptable rate of injury caused by the former. The estimated lynx density increased from 3.1 to 9.0/100km² between march 1987 and March 1989. Five of six lynx captured in 1986/87 were born before the previous snowshoe hare crash of January 1982. Subsequent immigrants and emigrants were of all age classes indicating an extremely flexible social organization. Only one natural adult mortality has been documented. The litter size and survival of kittens has increased throughout the study.

Ninety-five percent convex polygon home ranges averaged 16.3km² in 1987 and 25km² in 1988. These differences were not significant, nor were the sizes of male and female ranges. Ranges of males overlapped the ranges of females and other males, however female ranges did not overlap. Minimum daily travel distances (cruising radii) averaged 1.7km for males and 1.3km for females in 1987 and 2.0km and 1.7km for males and females, respectively in 1988. The difference between sexes was significant in 1987 only. Males travelled up to 3.0km daily in March 1988.

Commercial fur trapping effort and success increased in 1987/88 over the previous season. Trappers tended to increase their effort during the last half of the season even through success was greater during the first half. Almost twice as much effort was required to catch female lynx than male lynx.

The trapper questionnaire responses and lynx harvest over the past 9 seasons have tracked the lynx population, and the pelt measurement data has tracked the recruitment over the past 4 seasons. Following the hare crash in January, 1982, the lynx population of the southern Yukon rode out 5 years of low hare abundance - low recruitment (4 years in central Yukon), before a detectable change occurred in 1987/88.

Age structure and reproductive data from lynx carcasses collected in the southern Yukon substantiate this interpretation. In 1986/87, 85% of all lynx trapped were $\geq$ 5.5 years of age. By 1988/89, 67% were kittens or yearlings. Adults were harvested consistently throughout the season, while 72% of kittens and 75% of yearlings were harvested after December.

Based on kidney fat weights, males tended to be in better condition than females, and adults were in better shape than kittens or yearlings. The female pregnancy rate increased from 17% in 1986 to 72% in 1987. The *in utero* litter size increased from 2.3 in 1986 to 3.8 in 1988. The first breeding by yearlings was noted in 1988 when 33% bred and had mean placental scar counts of 2.7.

Lynx recruited before the hare crash were responsible for initiating the increase phase when hare numbers increased. Their demonstrated mobility and flexible social organization allows lynx to respond to local changes in the hare populations and exploit pockets of abundance. The maintenance of refugia (untrapped areas similar to those recommended for marten populations) may be necessary for allowing lynx to track hare populations and incidentally supply traplines. The best lynx refugia are quality hare population refugia (patches) which are maintained over the lynx cycle.

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INTRODUCTION

Lynx population abundance follows a high amplitude cycle caused ultimately by responses to fluctuations in abundance of its main prey, the snowshoe hare (Lepus americanus). Lynx radio-telemetry studies across North America have shown annual lynx trapping mortality rates to be over 50%. The lynx (Lynx canadensis) is in high demand by the fur trade, is easy to trap, and access and transportation methods are constantly improving over much of its range. These factors have prompted apprehension among furbearer managers, trappers, fur buyers, and animal welfare groups that lynx may be overexploited, effecting both the amplitude and timing of the lynx cycle. The greatest concern is in jurisdictions where trapping systems don't sufficiently restrict trapping pressure through the use of season length, quotas, limited entry, and/or closed areas.

Although the trapping regime of the Yukon includes a liberal season (Nov 1 - Mar 10) and no lynx quota, there is an effective limited entry system involving trapping concessions and group trapping areas. Trapping concessions are granted for successive 5 year terms to individual trappers (or partnerships or family groups) on 39 km^2 to 3752 km^2 areas ($\bar{x}$ = 823 ±648[SD]). Large group trapping areas (19,600 to 63,700 km^2) are granted as well, but are limited to Indian Band members. Through a combination of self-management and trapline inaccessibility, untrapped areas (refugia) form significant portions of the concessions. We believe that these refugia are producing a surplus of lynx for the traplines and help maintain normal lynx population responses to fluctuating snowshoe hare densities. The continued existence of these refugia may be critical to the future of the lynx harvest in the territory.

A study of lynx refugia was initiated in 1986 in the south-central Yukon. The objectives of the study were:

1. Determine if refugia are maintaining and stabilizing lynx populations in the face of excessive trapping. That is, are they producing a harvestable surplus of lynx that emigrate to be trapped in other areas?
2. Determine if trapping mortality is density dependent and/or are lynx more susceptible to trapping at some phases of the cycle than others.
3. Determine if trapping mortality is additive to or compensatory for non-trapping mortality.
4. Monitor the recruitment rate of the lynx population in relation to snowshoe hare abundance.
5. Combine this information with published lynx data in a computer simulation model to assess the merits of various proposed management strategies and provide the most effective long term management strategy for lynx.
6. Develop techniques for the ongoing monitoring of lynx population densities and recruitment rates.

Lynx predation ecology and habitat use were studied by Major (1989) both on our Snafu Lake study area and his own adjacent Tarfu Lake area (25 km southwest of Snafu) in 1987/88 and 1988/89. The radio-locations of our lynx were used in his analysis. The Habitat Section of the Yukon Fish and Wildlife Branch is also conducting snowshoe hare habitat assessments in other Yukon locations (R. Sumanik, Upland Specialist, unpubl. data).

This report summarizes results from our studies to June 1989. We also include a home range and litter size from male and female lynx radio-collared by Mr. Major on the Tarfu area. The discussion does not include a complete review of relevant literature, rather it includes selected exemplary references. Readers are referred to Hatler (1988) and Brittell et al (1989) for recent reviews of the lynx literature.

STUDY AREA

Live trapping is conducted on the southern half of registered trapping concession #327, which has been leased from the concession holder. The 282 km^2 area is a lynx population refugium, which had not been trapped for over 20 years prior to the study, and is surrounded by active traplines. The total contiguous untrapped area, including refugia on adjacent traplines, is approximately 500 km^2. The area is in the "Teslin Burn," on the Teslin Plateau (Bostock, 1965) west of Teslin (Figure 1). Elevations range between 900 and 1,500m above sea level, with Mt. Bryde, the highest peak, at 1,950m a.s.l. The topography is characterized by plateaus and weathered mountains dissected by creek and river valleys. Drainage is provided by the Teslin and Yukon rivers. Climate is summarized in Table 1. Johnson's Crossing is 30km north of the study area centre, and Teslin 35km east. The elevation of our Snafu Lake base camp is 877m a.s.l.

Table 1. Climate of the Teslin Burn Area.

		Mean Temperature (°C)				Mean Precipitation (mm)	
	Elevation	Annual	May-Sept	Jan.	July	Annual	June-Aug.
Johnson's Crossing	690m	-3	9	-26	13	346	132
Teslin	701m	-1	10	-20	13	326	99

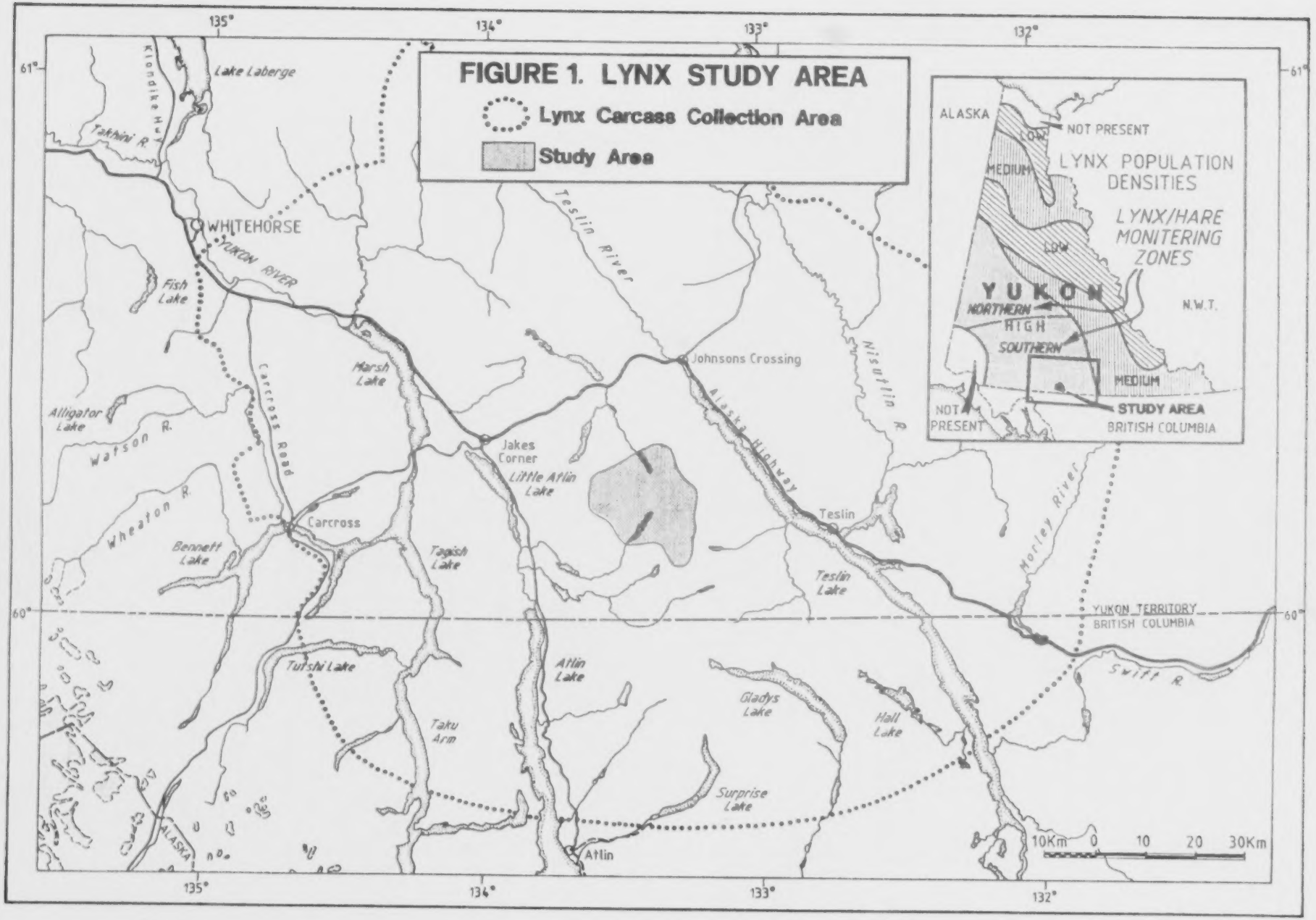


FIGURE 1. LYNX STUDY AREA
Lynx Carcass Collection Area
Study Area
135°
134°
133°
132°
61°
60°
Klondike Hwy
Lake Laberge
Takhini R.
WHITEHORSE
YUKON RIVER
Fish Lake
Marsh Lake
Carcross Road
Alligator Lake
Watson R.
Wheaton R.
Bennett Lake
Carcross
Tagish Lake
Jakes Corner
Little Atlin Lake
Johnsons Crossing
Teslin River
Nisutlin R.
Alaska Highway
Teslin
Teslin Lake
Morley River
Swift R.
YUKON TERRITORY
BRITISH COLUMBIA
Tutshi Lake
Atlin Lake
Taku Arm
Gladys Lake
Hall Lake
Surprise Lake
Atlin
ALASKA
10Km 0 10 20 30Km
ALASKA
NOT PRESENT
LOW
MEDIUM
LYNX POPULATION DENSITIES
LYNX/HARE MONITERING ZONES
YUKON
N.W.T.
NORTHERN
HIGH
SOUTHERN
MEDIUM
STUDY AREA
NOT PRESENT
BRITISH COLUMBIA

The area, in the "Lake Laberge Ecoregion" (Oswald and Senyk 1977), was burned in 1958, and consists of regenerating forest cover and some residual patches of mature lodgepole pine (Pinus contorta) and white spruce (Picea glauca). The main cover types, used in habitat analyses in this report are:

1. **Heavy burn, characterized by dense regenerating pine.** Willow (Salix spp.) predominates early successional stages, but tends to drop out as succession advances. The well developed shrub understory also includes shrub birch (Betula glandulosa). Lower shrub layer includes Ledum spp. Successional to white spruce/willow.

2. **Moderate burn.** As #1 above, but mixed with residual pine, and is more open, with less developed shrub layer and pine regeneration.

3. **Mature Pine.** A dense canopy of pine (over 50%), frequently including trembling aspen (Populus tremuloides) and white spruce. The shrub layer contains willows and shrub birch. Successional to white spruce/willow.

4. **Open pine.** As above, but with an open canopy and a less well developed shrub layer. On xeric sites.

5. **Closed white spruce/willow.** A ubiquitous white spruce community with a canopy cover under 30%. A high cover of medium height willows is characteristic while Ledum palustre dominates less well drained sites. Frequently contains lodgepole pine.

6. **White spruce/aspen.** As above, but with aspen occurring in younger stands, or stands on rock outcrops, windblown knolls, and steep southwest facing slopes. Aspen dominated sites also support Ledum groenlandicum, Juniperus communis, and Arctostaphylos uva-ursi in the understory. The aspen community type is often separated from the white spruce type, however, it is rare in the study area and always integrates with white spruce and so is lumped with the latter.

7. **Riparian/lowland willow.** A variable height shrub community which is an uncommon habitat feature in the study area. Observations (eg - track-counts) made in this type were attributed to the dominant surrounding forest cover type.

All of the above occur from lower elevations to treeline.

Approximately 8.0km^2 of standing water and 18.0km^2 of alpine tundra are present in the study area, with the remaining 256km^2 being forested habitats. Access is by aircraft/snowmachine in winter and aircraft/boat/horseback in summer. The area had been hunted by a big game outfitter until 1979 and there was a

network of horse trails throughout the area, although these proved to be of limited use for snowmachine travel. We cut more than 75km of snowmachine trails, accessing most of the major drainages in the area. The Teslin burn is popular for moose hunting in the fall and Snafu Lake receives light fishing pressure in the winter and spring.

The study area is within the zone of high lynx densities (based on fur harvest averages) (Figure 1).

METHODS

Field Research Program

Snowshoe Hare Abundance

We used 2 methods to estimate, and monitor changes in, snowshoe hare abundance within our study area. First, we established 360 permanent snowshoe hare turd quadrats on 9 transects during June 1987. The quadrats are 5.08 x 305cm, covering an area of $0.155m^2$. Transects were established in each of the habitat types. The annual production of turds on the quadrats was counted and the transects cleared of turds in late spring of each year. Hare densities for each habitat type were calculated using the methods developed by Krebs et al (1987). The confidence limits were estimated using combined errors of estimating the mean number of turds and the slope of the regression.

We also monitored hare abundance using track-count surveys. Track-counts were conducted throughout the winter on our trapline snowmachine trails. Counts were repeated as snow conditions and other duties permitted. Fresh tracks of lynx were also recorded[1]. Last snowfall was recorded to the nearest ½ day. The hare population index was presented as tracks/km-day [number of hare tracks crossing transect/(distance surveyed {km} x days since last snowfall)] and was used to compare the relative use of habitats and to monitor population changes. Hare runways, where an exact count of track crossings was not possible, were converted to tracks by multiplying by 3 x the number of days since last snowfall. Counts in habitat types were combined if sampling intensity in one type was <3.0 km-days.

1. A "fresh" track is one made after the last snowfall.

Lynx live-capture

Due to the inaccessibility of the study area, live trapping was limited to the winter months when snowmobiles could be used for transportation. The trapping season therefore extended between freeze-up and adequate snowfall accumulation in December and break-up in late March or early April.

Lynx were live-captured using a combination of Tomahawk live traps (Model 110A, 122 x 51 x 66cm, Tomahawk Live Trap Co., Tomahawk, WI), Woodstream soft-catch leg-hold traps ("Coyote" model, #3 coil spring, Woodstream Corp., Lititz, PA), and Freemont foot snare live traps (standard size, Freemont Humane Traps, Candle Lake, Sask.). The Freemont traps were modified by wiring on a 15 x 25cm weld- wire pan extension, and shortening factory snares, if necessary, to 85cm length. Traps were set in a variety of cubby and trail sets similar to those employed by professional fur trappers. A wide range of baits, scents, and visual lures were used. Traps were tied to heavy drags or fixed objects and were closed if the weather forecast was for temperatures below -25°C (leg-holds) or -30°C (foot snares).

Once captured, lynx were immobilized using 1 to 2cc of 6.7:1 ketamine-rompun mixture (ketamine hydrochloride 100 mg/ml, xylazine 100 mg/ml) injected by hand or jabstick. While immobilized, lynx were sexed, weighed, length and neck circumference measured, ear-tagged with a serially numbered tag (Monel, style 1005 size 3, National Band and Tag Co., Newport, KY). Age was estimated as kitten or adult and an incisor was extracted (usually I_3) from adults for aging by cementum analysis. All were fitted with collar-mounted radio transmitters (Model 400, Telonics Inc., Mesa, AZ).

Lynx Dispersal and Mortality

Lynx dispersal and mortality were monitored using aerial radio-telemetry techniques from a Maule M-7, Cessna 172 or Cessna 185. The receiving system included Telonics TR-2E receiver, TS-1 scanner/programmer and H-antennas (Telonics Inc., Mesa, AZ). The signals were isolated within 360° aircraft turns with radii of $\leq$ 500m, 100-150m above ground. Telemetry flights were done on a weekly basis throughout the year, and daily for up to 1 week during each of the breeding, natal, fall and winter periods. Ground-based telemetry was attempted and abandoned after it was discovered that the irregular, rocky terrain frequently produced signal bounce, resulting in erroneous signal directions. In addition, we had difficulty accessing several radio-collared lynx from our snowmobile trails.

Mortality of individuals in the area was determined by lynx activity. If an individual was in the same location over several telemetry flights, we located the animal using ground telemetry to determine if it had died. If an individual could not be located in the study area, and radio failure was not suspected, it was assumed to have dispersed. Telemetry flight paths were extended well outside our normal study area in an attempt to confirm this.

Recruitment and Immigration into the lynx population

Recruitment into our untrapped lynx population was assessed at 2 levels; the number of kittens born and the number of young surviving to the following winter. The number of kittens born was monitored by visiting the natal dens in late May or early June. Natal dens were located by monitoring the activities of radio-collared females on several successive days. If the female was repeatedly located in the same position, we assumed that she had kittens and

was at a den site. We then attempted to locate the den using ground telemetry. Once located, the kittens were weighed, aged, and ear-tagged for future identification.

Survival of the kittens to the following winter was assessed through a combination of recaptures of ear-tagged kittens and snow tracking adult females.

Immigration was assessed by the capture of new lynx of yearling or older age class (ie. not present the previous year) on the study area.

Lynx Density

We used two indices to monitor lynx density on our study area; known minimum number alive based on live-captures, and lynx track sightings in combination with and radio locations to estimate total density. Lynx track-counts, similar to the hare track-counts described earlier, were also recorded. Estimated lynx densities were compared with track-counts to see if a predictable relationship exists which will allow us to use track-counts as a population estimation technique. Lynx density was calculated for forested habitats only (i.e. - alpine tundra and standing water excluded), which comprise 90.8% of the total area.

Lynx Home Range and Daily Movements

Home Range analyses were performed using Ackerman et al's (1989) program Home Range for PC's. Considering the number of data points available per individual lynx and the potential for behavioural changes in response to changing snowshoe hare densities, we grouped the data into annual periods based on the hare

annual life cycle. Individuals with <20 locations were excluded from the analyses. Analyses performed include, 50, 95 and 100% convex polygons and mean distance between consecutive daily locations (ie. daily cruising radii). Ninety-five percent convex polygons reduce the effect of outliers and provide some information on area used within the 100% home range. The 50% convex polygon represents the core area of use. The observation furthest from the arithmetic centre was removed, a new arithmetic centre recalculated, then this was repeated until the required number of observations was removed.

Daily travel distance or cruising radii were also calculated for individuals from seasonal daily telemetry data.

Yukon Lynx Population Monitoring Program

We have 5 broad programs to monitor the lynx harvest and population status in the Yukon:

Trapper's harvest calendar

Harvest calendars were mailed to a large sample of trappers during the 1986/87 (n=100) and 1987/88 (n=200) seasons to monitor trapper effort and success throughout the season. Trappers recorded the number of traps set, the number of days they were set, and the number of lynx they caught on each day of the lynx trapping season. Due to a low return rate this program was discontinued in 1988/89.

Trapper Questionnaire

Questionnaires on lynx and hare abundance have been mailed annually to all licensed trappers since 1980/81 and 1976/77, respectively. The trappers were asked to answer questions based on their own experience over the past season on the concessions for which they were licenced. The response frequencies were tabulated and territory-wide population indices calculated from weighted averages.

The population level index was calculated as follows:

Trapper's Response	Weight (R_i)	Index (%)
Abundant	9	100
Common	5	55.56
Scarce	1	11.11
Not Present	0	0

$$\text{Index} = \left(\sum_{i=1}^{i=n} R_i\right)/9n \times 100\%, \text{ where } n = \text{number of valid responses.}$$

The high density lynx region (Figure 1) was split into a northern zone (lower Yukon R. basin from Carmacks to Dawson City) and a southern zone (upper Yukon R. basin from Carmacks to Teslin), to compare population levels and trends between the two geographic regions. The 1976/77 to 1983/84 hare population level indices were correlated with mean hare densities at Kluane Lake (C.J. Krebs, unpubl. data) to test the reliability of the indices.

Lynx Harvest

Fur harvest data was collected annually using mandatory fur trader records and fur export permits. All pelts entering the commercial fur trade are accounted for on a trapline and trapper specific basis. This system does not account for fur held over to the next year, fur sold privately or fur retained for personal use, such as in clothing. Since lynx is such a valuable fur which usually is exported to auction, most of the harvest was accounted for. The sealing of all lynx pelts became mandatory in 1988/89.

Lynx Carcass Analysis

To assess the age structure, sex ratio, body condition, and reproductive history of the lynx harvest adjacent to our study area, we purchased carcasses from trappers who operate within a 100km radius of the area (Figure 1). Lynx carcasses were sexed, weighed (if complete), body length, tail length and neck circumference measured, and kidney fat weighed. Kidney fat was used as an index of body condition. The reproductive tract of females was collected and examined. The absence or presence and number of placental scars, indicating breeding success during the past spring, were recorded. Teeth were extracted to determine age using the cementum annuli technique described by Matson (1981). We extracted both canine and an incisor to compare the effectiveness of using each tooth type for determining age.

Lynx Pelt Measurements

Lynx pelt measurements have been used to separate kitten and older (yearling and adult) lynx (Quinn and Gardner 1984, Stephenson and Karczmarczyk 1989, Poole 1989) for the purpose of assessing the status of the lynx's reproductive cycle. We wished to establish this relationship (age to pelt length) for the local lynx population, whose size is under environmental as well as genetic control, and may not be the same as that reported for other areas. Therefore, trappers who submitted lynx carcasses were asked to attach pelt width and length.

Lynx pelt measurements were collected from 1985/86 to 1987/88 by Fish and Wildlife Branch staff and cooperating fur dealers and members of local fur councils of the Yukon Trappers' Association. 63.4% of the total lynx harvest was sampled in this manner. Mandatory lynx pelt sealing was initiated in 1988/89. The data was grouped by pelt size class (standard Canadian fur auction classes) and analyzed by season for the northern and southern zones (Figure 1). The large-medium pelt class was subdivided into [86-89x23cm] and [<89-91x23cm] classes.

Difference between sample means were determined using the t test. **A level of significance of 5% was used.**

RESULTS

Field Research Program

Snowshoe Hare Abundance

Snowshoe hare density, as calculated from turd counts (Table 2), increased from 0.7 (0.6 to 0.9) hares/ha in 1987 to 1.7 (1.5 to 2.2) hares/ha in 1989. Hare densities in 1987 and 1988 were not significantly different. The heavy burn (pine/willow regeneration) was the preferred habitat throughout the study period. Densities were greater in all types in 1989, however significant increases occurred in closed pine and in the heavy and moderate burns. The greatest density of 3.0 hares/ha was noted in the heavy burn.

The hare track-counts (Table 3) indicated a more pronounced annual increase in hare activity and, presumably, hare abundance beginning in 1988. The pattern of habitat preference/avoidance was very similar to that described from the turd counts. The heavy burn, characterized by regenerating pine and willows, was preferred all 3 years, and the greatest increase in track-counts occurred in that habitat type also. The hare density estimates and hare track-counts for combined habitats and the heavy burn were significantly correlated ($r=1.00$ and $r=0.98$, respectively).

Trapper questionnaire responses (Figure 2) also indicated a progressive increase in hare numbers throughout the study period. The hare population level index was significantly correlated with known hare densities at Kluane Lake for the period 1976/77 to 1983/84 ($r=0.84$). Hare densities in the northern monitoring zone have been consistently greater than those in the south, the region encompassing our study area, throughout the cyclic increase phase.

Table 2 Hare Density Estimates from Turd Counts.

Habitat Type	Number of Quadrats	1987			1988			1989		
		Hare Density Estimate	95% Conf. Limits Lower	Upper	Hare Density Estimate	95% Conf. Limits Lower	Upper	Hare Density Estimate	95% Conf. Limits Lower	Upper
1. Heavy burn - Pine/willow regen	114	1.0	0.8	1.4	1.0	0.8	1.4	3.0	2.4	4.0
2. Moderate burn - Residual pine, pine/willow regen	59	0.5	0.4	0.6	0.5	0.5	0.7	1.0	0.8	1.4
3. Closed Pine	37	0.4	0.4	0.5	0.5	0.4	0.7	1.7	1.0	2.7
4. Open Pine	37	0.4	0.4	0.4	0.4	0.4	0.5	0.9	0.4	1.6
5. Closed White spruce/willow	86	0.6	0.5	0.9	1.0	0.7	1.6	1.2	0.8	1.9
6. Open White spruce/aspen	27	0.6	0.4	0.9	0.7	0.5	1.1	0.8	0.6	1.2
Total	360	0.7	0.6	0.9	0.8	0.7	1.0	1.7	1.5	2.2

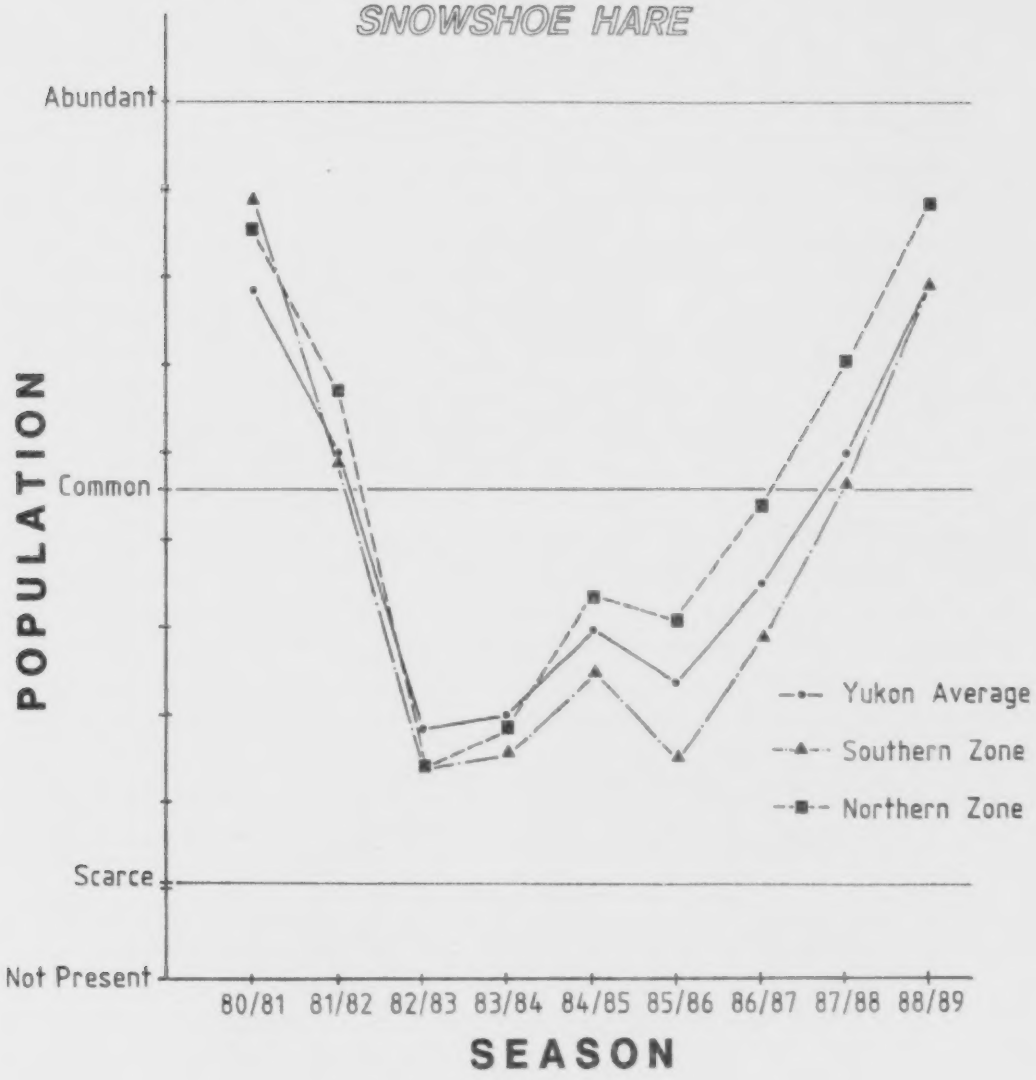
Table 3. Lynx and Snowshoe Hare Track-counts and Preference/Avoidance of Habitat Types.

Tracks/100 km-days

	Heavy Burn Pine/Willow	P/A[a]	Mod. burn w/residual pine	P/A[a]	Residual Pine-Closed	P/A[a]	Residual Pine-Open	P/A[a]	Closed Spruce /Willow	P/A[a]	Open Spruce /Aspen	All Combined
1986/87												
Lynx	0	-	21.6	-	20.2	+	0	-	27.1	+	.	18.1
Hare	404	+	754	-	20	-	269	+	706	+	.	621
km-days	25.1		139.1		9.9		24.9		62.8		0	271.3
1987/88												
Lynx	68.3	+	16.4	-	c		2.4	-	21.0	=	.	18.8
Hare	4500	+	1630	-			138	-	776	-	.	1887
km-days[b]	20.5/14.9		262.3/140.6				39.9/25.45		39.2/34.9		0	451.4/215.8
1988/89												
Lynx	354.2	+	102.9	-	d		.		184.1	-	e	187.7
Hare	22,625	+	6729	-			.		3949	-		9760
km-days[b]	4.8/4.8		8.8/4.3				0		15.8/9.5			29.3/18.9

a. Preference/avoidance of habitat types (+/-) was calculated after Neu et al (1974)
b. Lynx transects/Hare transects
c. 0.65 km-days, combined with Residual Pine-Open
d. 0.50 km-days, combined with Mod. burn
e. 0.75 km-days, combined with Closed Spruce/Willow

FIGURE 2. YUKON TRAPPER QUESTIONNAIRE POPULATION LEVEL INDICES, 1980/81 to 1988/89



Lynx Live-Capture Effort and Success

Trapping effort ranged from 2,707 trap-nights(tn) (sum of number of traps set/night of trapping period) in 1986/87, to 6,180tn in 1987/88 (Table 4). At the height of trapping we employed approximately 10 box traps (all years), 50 leg-holds (1986/87 and 1987/88 only), 30 foot snares in 1987/88 and 80 foot snares in 1988/89. The shift from leg-holds to foot snares was made due to their greater capture efficiency (1.65 x greater than that of the leghold in 1987/88) and lower injury rate. Other than minor lesions, the leg-holds were responsible for 5 cases of freezing damage and 2 broken digits in 13 capture, while in 24 captures in foot snares, there was one large cut and one compound leg fracture. The foot snare-related injuries were probably due to the greater radius of mobility available to lynx (90 cm vs 20 cm for leg-hold). Large box traps were considered too expensive and bulky for exclusive use on our large remote trapline. These we used for holding animals during recovery from immobilization. The overall success increased from 451tn per capture in 1986/87 to 318tn per capture in 1988/89.

Table 4. Lynx Live-Capture Effort and Success.

Trapping Period	Trap Type	Effort (Trap-nights)	Success (Lynx Captures)	Trap-nights Per Capture	Other Species Captured
1986/87	Leg hold	2,473	5	495	1 red fox
22 01 87-	Box trap	234	1	234	--
26 03 87	Total	2,707	6	451	
1987/88	Leg hold	3,812	8	476	2 red fox
23 12 87-	Foot snare	1,729	6	288	1 wolverine
10 04 88	Box trap	639	1	639	--
	Total	6,180	15	412	
1988/89	Leg hold	56	0	-	--
05 01 89-	Foot snare	4,991	18	277	3 wolverine
16 04 84	Box trap	668	0	-	--
	Total	5,715	18	318	

Males had significantly longer body lengths than females (Table 5). Neck circumference did not differ significantly between sexes. Kittens (sexes combined) had significantly smaller body lengths and neck circumferences than both male and female adults. Neck circumferences of individuals also appeared to be correlated with body weight although few data on neck circumferences were obtained from recaptures. Sam and Denny, who lost weight during the winter, had loose fitting collars when recaptured.

Table 5. Physical Measurements of Yukon Lynx.

$\bar{x} \pm$ SD cm(n)	Body length[1]	Tail length	Neck Circumference
Male[2]	91.9 ± 2.1 (11)	11.5 ±1.0 (11)	22.7 ± 1.2 (12)
Female[2]	87.6 ± 3.5 (7)	10.8 ± 0.93 (7)	21.5 ± 1.8 (7)
Kitten	77.4 ±2.8 (5)	10.5 ±1.0 (5)	18.8 ± 1.0 (5)

[1] to base of tail

[2] $\geq$ 1.5 years of age

Sex and Age of Live-captured Lynx

The sex ratio of our live-captured lynx favoured males in each year of study. During 1986/87, 4 of 6 lynx (66.7%) were males. In 1987/88, 8 of 11 (72.7%) lynx live-captured were males and in 1988/89, 9 of 16 (56.3%) were males.

The age structure of our study area lynx population shifted from older-to younger-aged animals over the 3 years of our study. All 6 lynx live-captured during the 1986/87 season were adults. In 1987/88, 10 of 11 lynx captured were adults, while in 1988/89, 13 of 17 lynx were adults.

Body Condition of Live-Captured Lynx

Body weight was used as an index of body condition. Average initial capture weights of adults remained relatively consistent between successive years of the study. Average capture weight during 1986/87 was 11.4kg (10.0-14.0)(Table 6). During the 1987/88 and 1988/89 trapping seasons the average capture weights were 12.1 (9.5-13.5) and 11.5kg (8.5-13.5) respectively. Differences between years were not significant. Males (12.2 $\pm$ 1.2kg) weighed significantly more than females (11.0 $\pm$ 1.1 kg). Weights of individuals tended to increase between seasons (Mickey, Evelyn, Hugh, Vern, and Alex, Table 6). Only 2 individuals lost weight between seasons (Denny and Virginia, Table 6). Individuals recaptured during the winter tended to lose weight as the season progressed (Mickey, Denny, and Sam, Table 6).

Table 6. Summary of Lynx Live-Captures and Fates.

Lynx ID	Capture Date	Sex	Age	Weight (kg)	Fate	Ambient Temperature °C Minimum	Ambient Temperature °C Maximum	TRAP[1] TYPE	Capture[2] Point	Physical Assessment
Mickey	31.01.87	F	7½	10.0		-20	-12	L.H.	R-F	-digits #3 and 4 frozen
	23.01.88		8½	11.8		-11	- 1	L.H.	L-F	-lost digit 3 (proximal phalnax) and 4 (distal phalanx) from previous capture. Some freezing.
	27.02.88			11.5	Residing in area Natural mortality between 25 04 88 and 16 05 88	-17	+ 2	F.S.	R-F	-no lesions, losing middle phalanx and #3 distal phalanx from previous capture (L-F).
Evelyn	02.03.87	F	10½	10.0		-40	-25	L.H.	L-H	-digit #2 broken
	13.04.89		12½	11.5	Residing in area	-13	+ 8	F.S.	R-F metacarpals	-no lesions this capture, had lost proximal phalanx of L-H digit #2.
Tom	10.03.87	M	7½	11.0		-25	- 2	L.H.	R-F	-Digits #2, 3, 4, and 5 frozen
	29.11.87			-	Dispersed 225 km NW & trapped	-	-	-	-	-Carcass not recovered, trapper reported digits missing.
Hugh	15.03.87	M	6½	13.0		-27	+ 2	L.H.	R-F	-Digit #5 broken
	26.02.88		7½	13.5	Residing in area	- 5	0	L.H.	L-F	-Cut in webbing between digits #3 and 4. Some minor freezing to digits #3 and 4.
Vern	21.03.87	M	6½	11.0		-20	+ 3	B.T	-	-Small cuts on nose. In trap one hour
	17.02.89			13.5	Residing in area	-31	- 8	F.S.	R.F. digits 3, 4, and 5	-Distal & middle phalanges swollen on digits 3, 4, and 5.
Felix	24.03.87	M	2½	11.0		- 2	+ 3	L.H.	R-F metacarpals	-no lesions
	01.03.89			11.7		- 7	0	F.S.	R-F	-no lesions from this or previous capture
	09.03.89			13.3	Residing in area	-43	-20	F.S.	L-F digit #2	-no lesions this or previous capture

Table 6 continued

Lynx ID	Capture Date	Sex	Age	Weight (kg)	Fate	Ambient Temperature °C Minimum	Ambient Temperature °C Maximum	TRAP[1] TYPE	Capture[2] Point	Physical Assessment
Denny	16.01.88	M	1½	14.0		-15	- 6	F.S.	?	-no lesions
	23.03.88			10.5		-18	+ 4	F.S.	L-F	-no lesions on capture foot. Large cut requiring 16 stitches on R-F leg.
	09.03.89			12.5	Residing in area	-43	-20	F.S.	L-F 4 digits	-no lesions, no sign of previous injury
Sam	22.01.88	M	6½	13.5		-11	- 1	B.T.	-	-Small cuts on nose, under eyes
	01.03.88			12.5		- 7	0	F.S.	L-F 3 digits	-No lesions
	03.04.88			10.0	Residing in area Live capture mortality	- 4	+ 1	L.H.	L-F 4 digits	-No lesions, from this or previous capt
Jerry	09.02.88	M	2½	13.0	Unknown: last location 26.10.88	-29	-15	L.H.	R-F	-Digits #3 & 4 frozen, some freezing of pad.
Virginia	17.02.88	F	3½	12.5		-17	0	L.H.	L-H (1 digit) +R-H (2 digits)	-No lesions
	05.03.89			11.5	Residing in area	-21	-12	F.S.	R-F digits #3, 4, and 5	-No lesions from this or previous captures.
Celina	11.03.88	F	9½	9.5	Unknown: last location 05.10.88	- 5	+ 6	L.H.	L-H digit #2	-No lesions
Randi	20.03.88	M	6½	12.0	Unknown: last location 26.10.88	-13	+ 3	F.S.	R-F	-No lesions
Luke	22.03.88	M	½	6.0	Unknown: last location 02.12.88	-18	+ 4	L.H.	R-F	-No lesions
Alex	29.03.88	M		12.8		-10	+ 5	L.H.	L-F	-No lesions
	17.03.89		6½	13.0		-27	0	F.S.	L-F wrist	-No lesions for this or previous capture
	01.04.89			?		-10	+ 5	F.S.	R-H above heel	-No lesions
	07.04.89			13.1	Residing in area	-23	+ 1	F.S.	R-F metacarpals	-All toes swollen, no previous injuries

Table 6 continued

Lynx ID	Capture Date	Sex	Age	Weight (kg)	Fate	Ambient Temperature °C Minimum	Ambient Temperature °C Maximum	TRAP[1] TYPE	Capture[2] Point	Physical Assessment
Paula	09.03.89	F	½	7.0	Residing in area	-43	-20	F.S.	R-F wrist	-No lesions
Tiphonse	13.03.89	M	½	7.2	Residing in area	-31	- 7	F.S.	R-F metatarsals	-No lesions (1 hour in trap)
Cam	20.03.89	M	5½	11.0	Residing in area	-15	+ 4	F.S.	R-F wrist	-Small cut (minor)
Noluck	27.03.89	F	8½	11.3	Live capture mortality	-19	- 8	F.S.	L-F wrist	-Compound fracture (ulna and radius)
Tasha	03.04.89	F	3½	10.5	Residing in area	- 6	+ 3	F.S.	L-F wrist	-Bruise at capture point
Koona	03.04.89	M	2½	10.0	Residing in area	- 5	+ 4	F.S.	R-H metatarsals	-No lesions
Tena	03.04.89	F	½	6.5	Residing in area	- 5	+ 4	F.S.	R-F metacarpals	-No lesions
Cecile	03.04.89	F	5½	8.5	Residing in area	- 5	+ 4	F.S.	L-H	-Digits #2, 3, 4, and 5 swollen
Sylvester	12.04.89	M	1½	12.5	Residing in area	-13	+ 4	F.S.	L-F wrist	-No lesions
Mick	14.04.89	M	½	6.0	Residing in area	0	+ 9	F.S.	R-F metacarpals	-No lesions

1. L.H. = padded leghold, F.S. = foot snare, B.T. = box trap
2. F = Front, H = Hind, L = Left, R = Right

Lynx Dispersal and Mortality

We classed mortalities in 1 of 3 categories; natural, live-capture related or mortalities of lynx that dispersed from the area and were trapped elsewhere. To date, we have recorded 4 lynx mortalities, including 1 natural mortality, 1 dispersal-trapping mortality, and 2 live-capture related mortalities (Table 6).

The only confirmed dispersal and trapping mortality recorded was that of an adult male (Tom). He was radio-collared in March 1987 and dispersed in May 1987 after being resident in the area for at least 2 months. After leaving our area, he travelled 225km northwest and was trapped on November 29, 1987 near Carmacks. He had survived less than a month after the start of the trapping season (Nov. 1).

We also lost track of four radio-collared individuals (Celina, Jerry, Luke, and Randi) during the fall of 1988 (Table 6). One of these (Luke) was a yearling, and the rest were adults. We do not know whether these individuals dispersed or if their radio-collars failed prematurely. Assuming they dispersed, dispersal rates were therefore 17% in 1987 and 31% in 1988.

The natural mortality was that of a 8.5 year old female (Mickey) during the spring of 1988. The radio-collar and remains of the carcass were not located until late June when the exact cause of death could not be determined. The natural mortality rate of adults was therefore 0% of 6 in 1987 and 7.7% of 13 in 1988. Kitten mortality is dealt with in the recruitment section.

Recruitment and Immigration into the lynx Population

The birth rates and denning habitats of study area lynx are summarized in Table 7. Six of 8 dens were in dense pine deadfall patches, one was in a mature spruce blowdown patch, and one was under a willow thicket in open standing spruce.

Table 7. Birth Rates and Den Site Selection of Study Area Lynx

Year	ID	Age (in May)	No. kittens	Denning Habitat
1987	Evelyn	11	4	Hillside, SE aspect, spruce blowdown in mature spruce.
	Mickey	8	3	Hillside, S aspect, pine deadfall (burn)
1988	Evelyn	12	4[A]	unknown
	Virginia	4	3[A]	Hillside, ? aspect, pine deadfall (burn)
	Celina	10	3[A]	Hillside, S aspect, pine deadfall (burn)
1989	Evelyn	13	4	Flat bench, pine deadfall (burn)[B]
	Virginia	5	6	Hillside, N aspect, willow and thicket in open mature spruce.
	Cecile	6	0	--
	Tasha	4	6	Hillside, S aspect, pine deadfall (burn)
	Tena	1	0	--
	Paula	1	0	--
	Nannette	-	5	Flat bench, pine deadfall (burn)

A Winter litter sizes based on 1988/89 live-trapping and snow tracking.
B Location different from 1987 den site, which was 3.75 Km south of 1989 site.

On June 1 and June 3, 1987, we located the natal dens of both radio-collared females. One female had a litter of 3 and the other female had a litter of 4. The kittens weighed $\leq$ 400g when tagged. Based on the body weight growth curves described by Jackson (1987) for bobcats (Lynx rufus), we believe that these kittens were approximately 2 weeks old. According to Lindemann (1955) and Guggisberg (1975), lynx eyes open in 12-17 days, supporting our belief that

these kittens were 2 weeks old or less. It was not possible to sex them. The fate of the 1987 kittens was unknown. None were re-captured the following winter (1987/88). Snow tracking during the following winter also suggested that survival was poor. Only one set of kitten tracks was recorded in the areas occupied by these females. One kitten, travelling with another, was trapped and radio-collared in another portion of our study area during the winter of 1987/88. From these observations, we can confirm the successful rearing of only 3 kittens.

We were unsuccessful in locating the natal dens of our 2 radio-collared lynx June 20-23, 1988. The behaviour of the females as we approached suggested that they did in fact have young. This is supported by winter trapping success and snow tracking during the following winter. During our 1988/89 live trapping season, we captured and radio-collared 4 kittens. We believe 3 of these were the young of our 2 radio-collared females. Snow tracking suggested that a total of 10 kittens were successfully reared by 3 females in our area during 1988/89. To summarize the kitten mortality rates then, 6 of 7 (86%) kittens produced by radio-collared females in 1987 are believed to have died. Kitten mortality in 1988 was at most 33-45% (based on maximum possible litter sizes) and may have been 0%.

We located the dens of 3 of 6 radio-collared females on June 1-3, 1989. The litter sizes were 4, 6, and 6. The other three females, including two 1988 kittens did not show an affinity for a particular location on successive daily telemetry flights during this period. Two of the females with kittens were extremely aggressive, not letting us close to obtain body weights of their

young. One litter was ear-tagged while the female was held at bay. Two of the litters were estimated to be 2 weeks of age, and the other, with open eyes, may have been 3 weeks of age. A female from the Tarfu study area (Nannette, Table 7) had a litter size of 5 when located on June 16, 1989. Her kittens averaged 500g which would place them at 3-4 weeks of age (Jackson 1987).

Based on the estimated ages of the 6 lynx litters we have observed, birth occured between May 13-26. The birth date of 4 of the litters was estimated to be May 18-20. The other 2 litters could have been on these dates also.

Seven new lynx (6 adults, one yearling), captured in 1987/88 and 6 (5 adults, one yearling) during 1988/89 (Table 6), are possible immigrants to the study area. Two of the adult and the yearling lynx of 1987/88 could have been animals that we failed to catch in 1986/87, and similarly two of the 1988/89 lynx could have been missed in 1987/88. Regardless, the 1988/89 adult would have had to be an immigrant in 1987/88 if not in 1988/89. Therefore, at least 4 (or 5) lynx were immigrants in 1987/88, and 5 (or 4) were immigrants in 1988/89.

Lynx Density

Based on our live capture and snow-tracking data, estimated lynx density and minimum number alive in the area have increased in each year of the study (Table 8). In March of 1987, we estimated 8 lynx to be on the study area for a density of 3.1 lynx/100 km^2 of forested habitat. We estimated 16 lynx residing in the area in March, 1988 for a density of 6.3 lynx/100 km^2. In March, 1989 we estimated 23 lynx on the area for a density of 9.0 lynx/100 km^2.

Table 8. Minimum number alive and estimated lynx densities/100km^2 of forested habitats on study area, March 1987 to March 1989.

Date	Minimum Number[1] Alive	Density[2]	Estimated Number[3] Alive	Density[4]
March, 1987	6	2.3	8	3.1
March, 1988	13	5.1	16	6.3
March, 1989	16	6.3	23	9.0

1. Radio-collared lynx
2. Based on number of lynx radio-collared
3. Estimated from snow tracking and radio-telemetry. Uncollared individuals were 2 adults in 1987, 1 adult + 2 kits in 1988, 1 adult + 6 kits in 1989.
4. Based on estimated number alive.

The increases in density were supported by winter track count increases between 1987/88 and 1988/89 only; there was no significant increase in overall track-counts between 1986/87 and 1987/88 (Table 3). The correlation between lynx track counts in combined or heavy burn habitat types and lynx density (in March) was not significant (r=0.84 and r=0.92, respectively).

Lynx Home Range and Movements

The 1987 and 1988 lynx home ranges are shown on Figures 3 and 4, respectively. Male ranges ($\bar{x}$ = 25.0 $\pm$8.1km^2) were not significantly larger than female ranges ($\bar{x}$ = 14.4 $\pm$9.3km^2), within seasons. Ninety-five percent minimum convex polygon areas for March-December, sexes combined, averaged 16.3 $\pm$6.0 (SD)km^2 in 1987 and 25.0 $\pm$10.6km^2 in 1988 (Table 9). These means were not significantly different. One-hundred percent and 50% convex polygons were also not significantly different between years. Longer term home ranges are also given in Table 9. In 1987, only Hugh and Evelyn had overlapping home ranges (Figure 3), and members of the same sex did not overlap. There was considerable

Table 9. Summary of Lynx Home Ranges

	Minimum	Convex	Polygon	(km^2)
March-December 1987				
Males	100%	95%	50%	n
Hugh	18.4	14.0	4.6	67
Felix	24.4	18.4	6.2	64
Vern	36.8	24.5	5.9	66
Females				
Mickey	18.6	15.4	4.2	68
Evelyn	22.4	9.4	2.2	67
Mean	24.1 ±7.5	16.3 ±6.0	4.6 ±11.6	
March-December 1988				
Males				
Hugh	27.7	15.8	3.3	31
Vern	42.6	33.3	8.6	22
Felix	55.6	33.9	5.9	29
Denny	32.7	27.7	7.2	29
Luke	41.2	32.2	1.3	31
Females				
Celina	20.9	5.7	0.64	27
Virginia	33.0	27.0	8.1	31
Mean	36.2 ±11.3	25.1 ±10.6	5.0 ±3.3	
Others				
Shawn*(Mar-Dec '88)	84.9	54.0	13.2	26
Tom (Mar.-May '87)	29.9	26.8	5.7	25
Jerry (Feb.-Oct.'88)	41.2	32.2	1.3	31
Randi (Mar.-Oct'88)	152.7	24.3	9.4	22
Alex (April-Dec.'88)	93.5	77.5	8.2	22
Long-Term				
Hugh (Mar.'87-Apr.'89)	41.9	25.8	8.5	117
Vern (Mar.'87-Apr.'89)	60.3	39.5	6.8	102
Felix (Mar.'87-Apr.'89)	108.9	51.9	8.2	106
Denny (Jan.'88-Apr.'89)	38.3	31.6	11.1	46
Alex (Apr.'88-Apr.'89)	158.9	133.9	14.9	33
Mickey (Feb.'87-Jul.'88)	20.1	15.9	4.9	90
Virginia (Feb.'88-Apr.'89)	35.8	30.5	13.9	38

* Tarfu study area

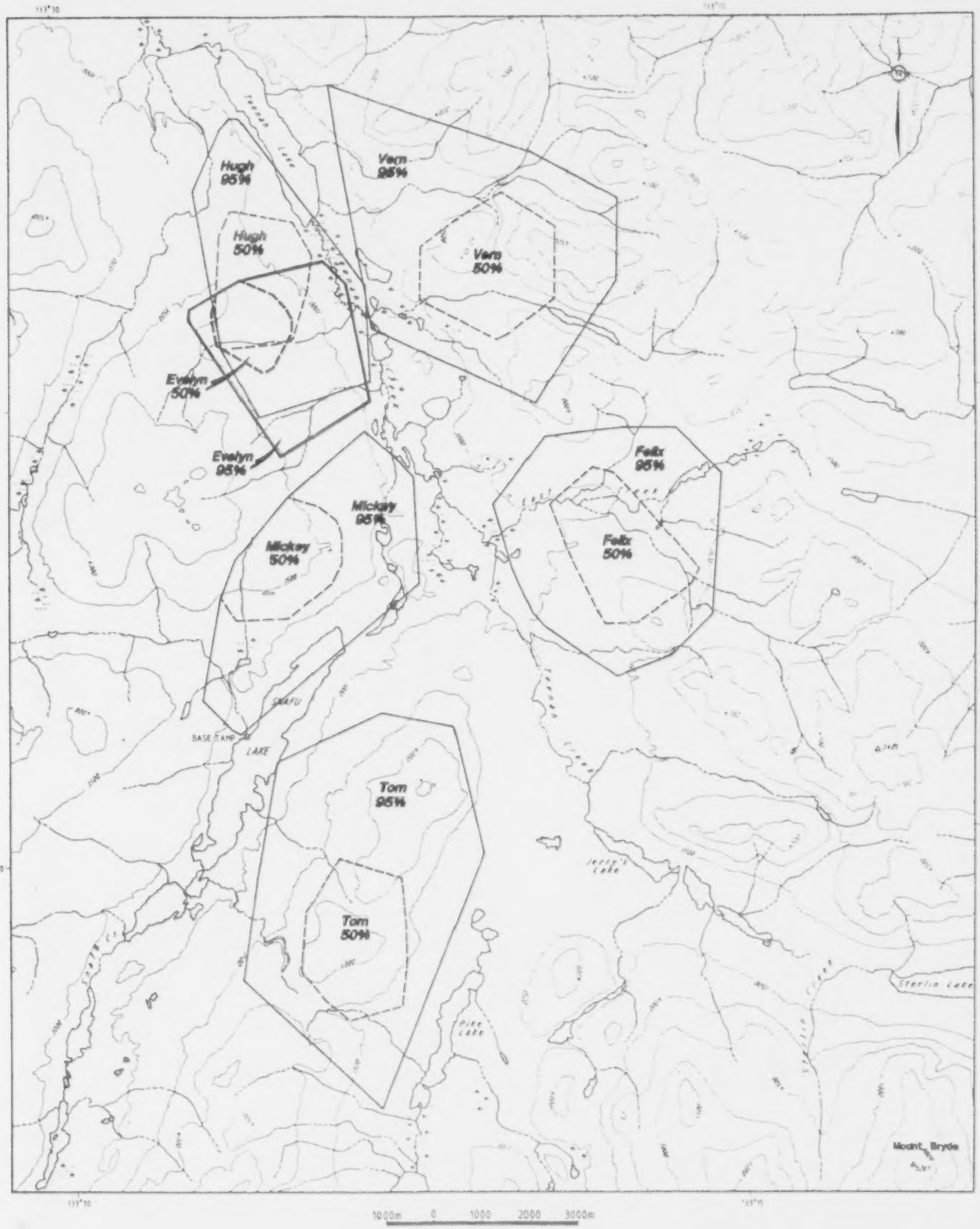


FIGURE 3. 1987 LYNX HOME RANGES – SNAFU STUDY AREA

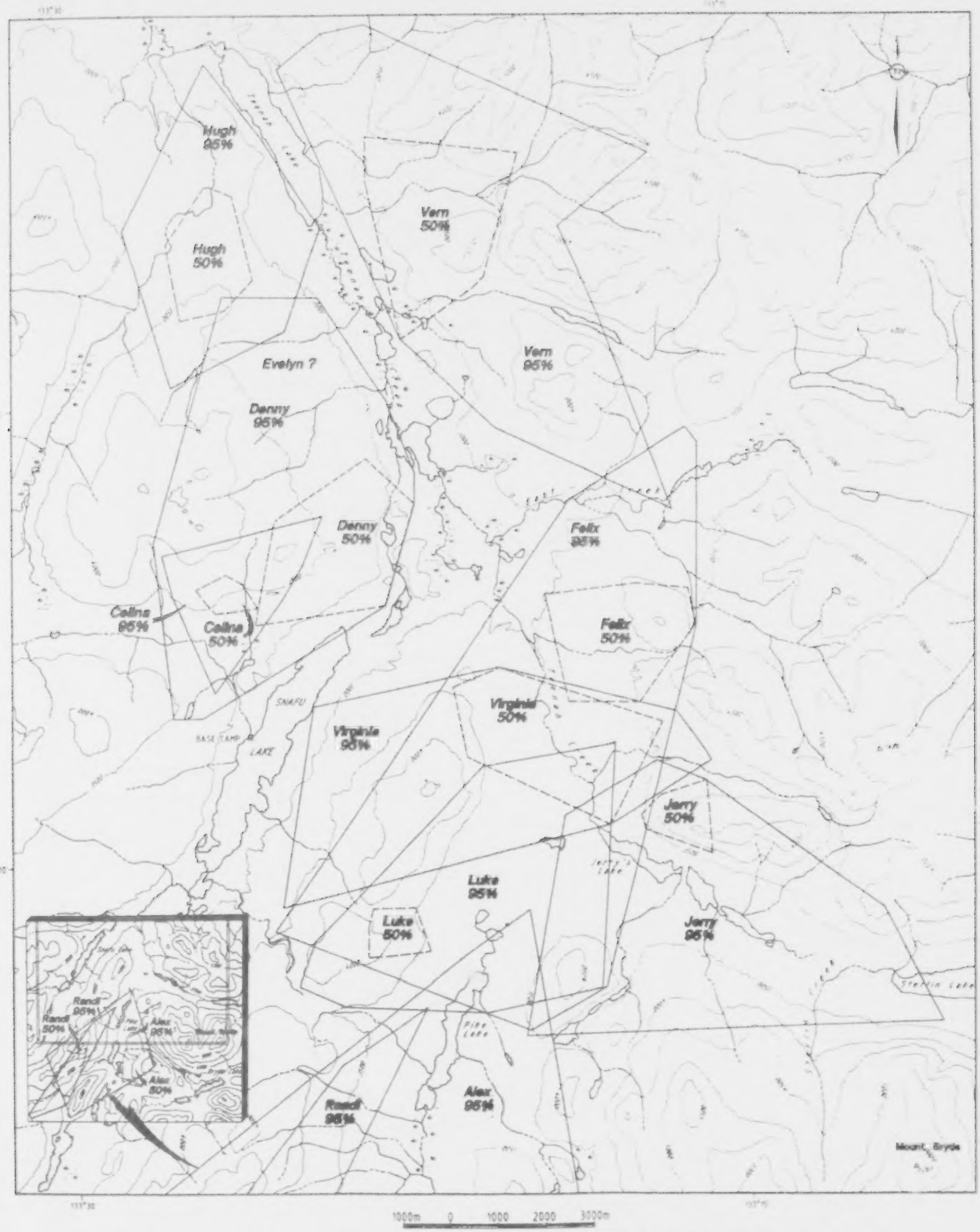


FIGURE 4. 1988 LYNX HOME RANGES – SNAFU STUDY AREA

overlap of male and female ranges again in 1988 (Figure 4). Male ranges also overlapped in 1988. Female ranges did not overlap in either year. Three males, monitored both years, showed evidence of range shifting, especially of the core use areas (Figure 5).

Mean minimum daily travel distances (DTD's) for seasonal periods in 1987 and 1988 are given in Table 10. The only significant differences between sexes within seasons occurred in May 1987 and March 1988 when males moved longer distances. The only significant difference in DTD's between years within sexes occurred in March-April when males moved further in 1988. DTD's were not significantly different for combined sexes between seasons. Male and female DTD's differed significantly in 1987, but not in 1988.

Table 10. Lynx Minimum Daily Travel Distances (DTD's)(km).

	March-April, 1987	March 23-26, 1988
Males	1.8 ± 1.4(67)	3.0 ± 1.7 (16)
Females	1.5 ± 1.4 (33)	1.3 ± 1.3 (9)
	May 22-26, 1987	June 17-24, 1988
Males	2.8 ± 1.7 (12)	2.2 ± 1.0 (32)
Females	1.2 ± 1.2 (8)	2.5 ± 3.8 (11)
	August 17-22, 1987	September 30-October 5, 1988
Males	0.91 ± 0.35 (15)	1.3 ± 1.1 (34)
Females	1.0 ± 0.05 (10)	1.2 ± 1.3 (8)
	November 23-29, 1987	
Males	1.2 ± 0.57 (12)	----------
Females	0.91 ± 0.39 (8)	
Total Males	1.7 ± 1.3 (106)	2.0 ± 1.7 (82)
Females	1.3 ± 1.2 (59)	1.7 ± 2.6 (28)
Combined	1.6 ± 1.3 (165)	1.9 ± 1.9 (110)

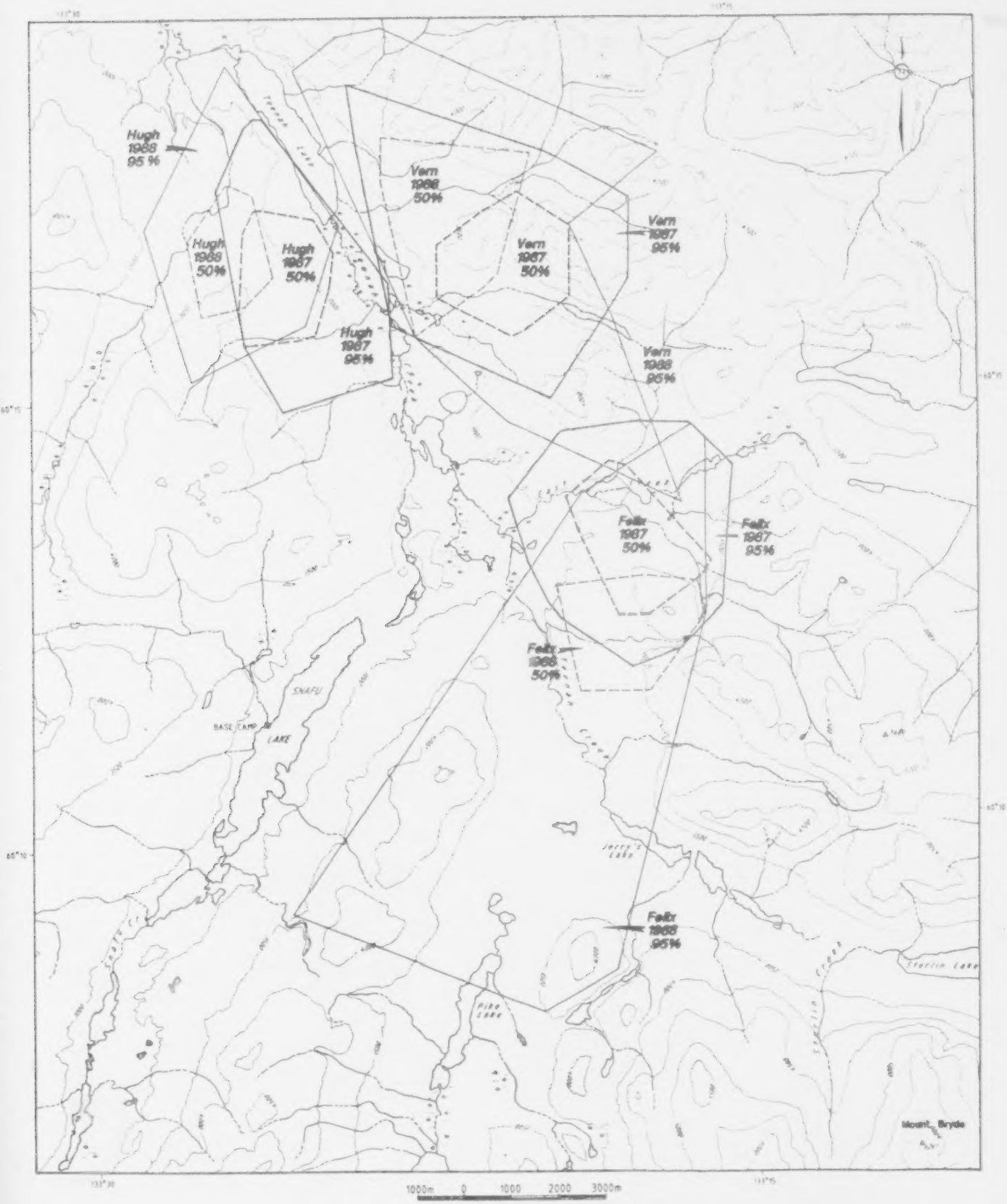


FIGURE 5. COMPARISON OF 1987 and 1988 LYNX HOME RANGES

Yukon Lynx Population Monitoring Program

Trapper's Harvest Calendar

Completed harvest calendars were returned by 14 trappers in 1986/87 (2 northern zone: 9 southern zone: 2 unknown traplines) and 11 trappers in 1987/88 (8:2:1). Trappers put more effort into lynx trapping during the 1987/88 season than the 1986/87 season (Figure 6). During the 1986/87 season, trappers exerted an average of 1,218 trapnights (tn) effort in trapping lynx. During the 1987/88 season, lynx trapping effort increased to 2,126tn. Trapping success also increased in 1987/88 (Table 11). Almost twice as much trapping effort was required to catch female lynx than male lynx in both years (Table 11). Trappers put more effort into lynx trapping in the last half of the season (Table 12).

Table 11. Average Trapping Effort and Success by Yukon Trappers. Based on Harvest Calendar Returns.

Year	Average Number of Lynx Caught	Average Effort per Lynx Caught (tn)	Average Effort per Female Caught (tn)	Average Effort per Male Caught (tn)
1986/87	3	406	1,167	609
1987/88	6	354	1,020	532

Table 12. Trapping Effort and Success by Month by Yukon Trappers. Based on Harvest Calendar Returns.

	November - December		January - February	
Year	Average Trapping Effort (tn)	Average Effort per Capture	Average Trapping Effort (tn)	Average Effort per Capture
1986/87	426	224	792	465
1987/88	689	191	1,437	342

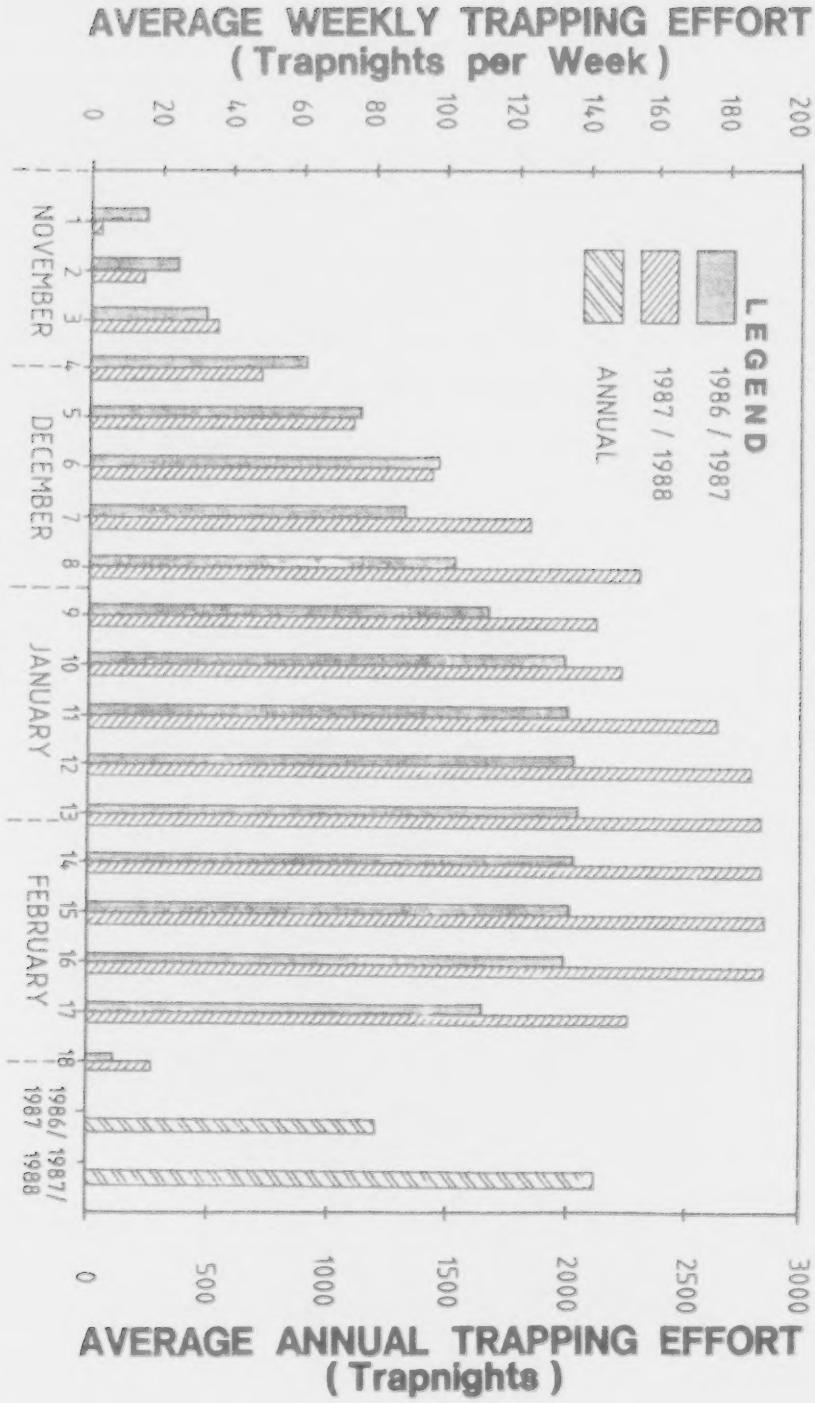


FIGURE 6. AVERAGE LYNX TRAPPING EFFORT BY WEEK AND SEASON FOR 1986 / 87 AND 1987 / 88 *

* Based on Trapper's Harvest Calendar.

Despite increased trapping effort, trappers were generally less successful at trapping lynx (in terms of catch per unit effort) during the last half of the season (Jan-Feb) than during the first half (Nov-Dec) (Table 12).

Trapper Questionnaire

The annual response rate to the questionnaire was 40-50% of all licenced trappers contacted (i.e. 250-300 trappers).

The lynx population level index did not show an increase until 1986/87 in the northern zone, and 1987/88 in the southern zone (Figure 7). The overall Yukon average index did not increase until 1988/89, presumably due to the effect of responses form lower capability lynx habitats (Figure 1).

Lynx Harvest

Historically, the peak lynx harvest occurred during the winter of the snowshoe hare peak and crash (1981/82) (Figure 8). The harvest was relatively high the following winter, but remained low and stable for the following 6 seasons. A slight increase in the harvest was evident in the last two seasons. The harvest density of lynx on active traplines has ranged from 1.3/100km² in 1981/82 to a low of 0.2/100km² in 1986/87.

Lynx Pelt Measurements

The pelt measurements of 123 known age lynx are shown in Figure 9. The $\leq$ 89cm cutoff between kittens and adults correctly aged 78% of the kittens and 78% of the adults. A $\leq$ 91cm cutoff would have been correct for 96% of the kittens and 74% of the adults. Using our data, 89cm should be used when kittens comprise < 20% of the harvest, and 91 cm when $\geq$ 20% of the harvest is kittens. The 89cm

FIGURE 7. YUKON TRAPPER QUESTIONNAIRE POPULATION LEVEL INDICES, 1980/81 to 1988/89

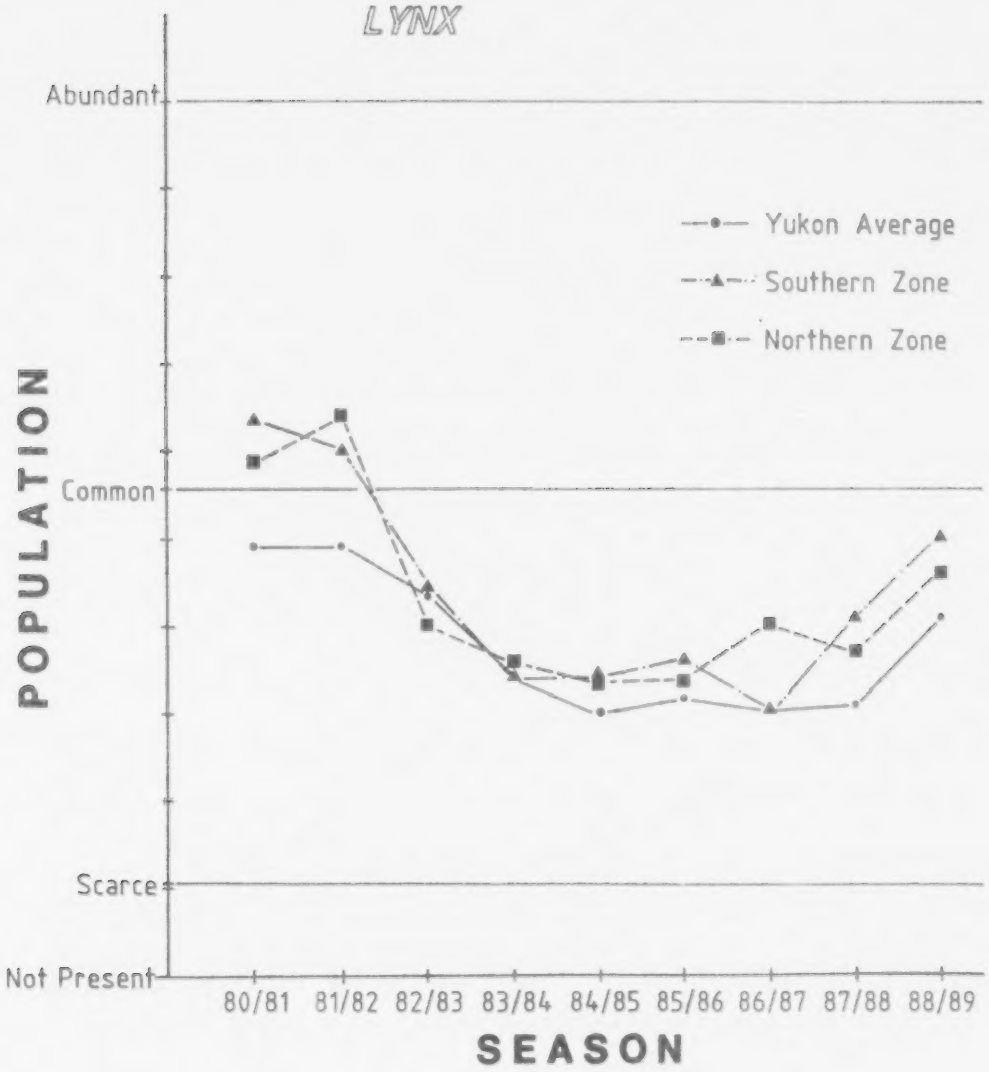


FIGURE 8. YUKON LYNX HARVEST 1980/81 to 1988/89

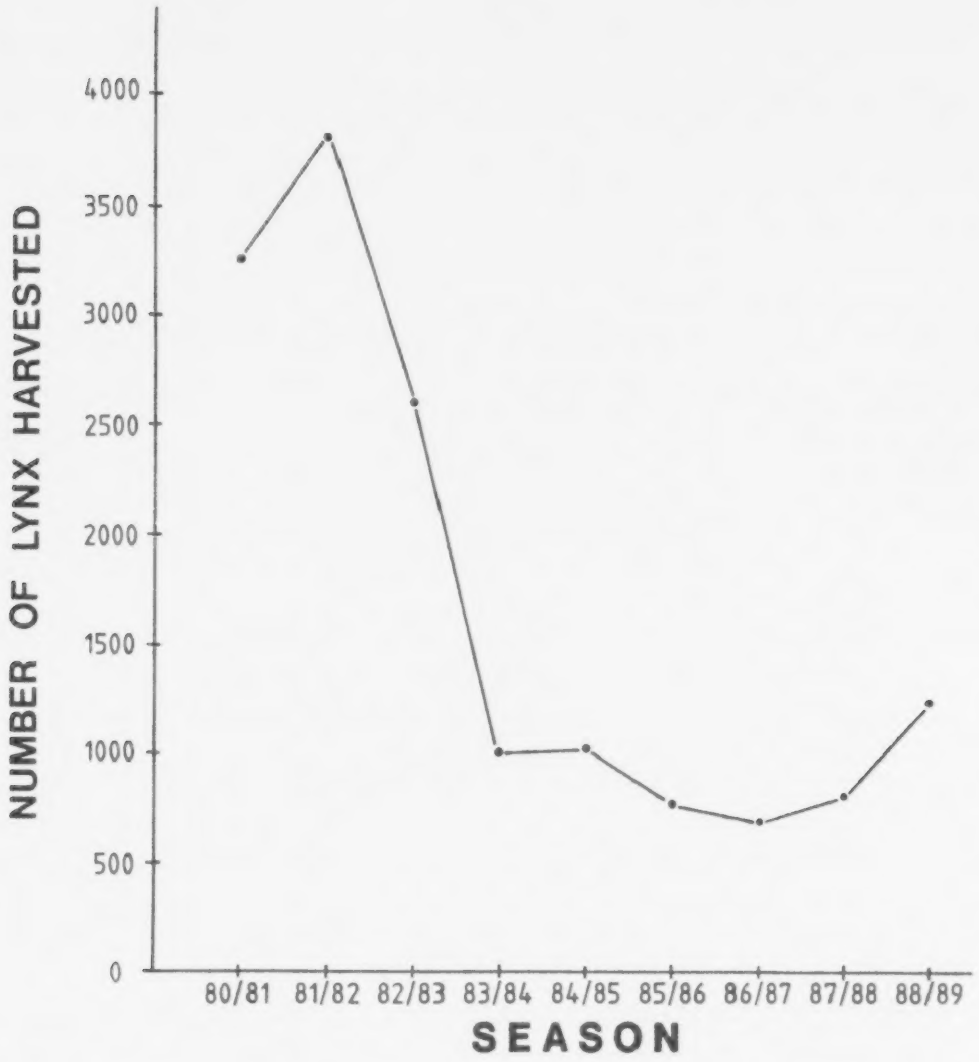
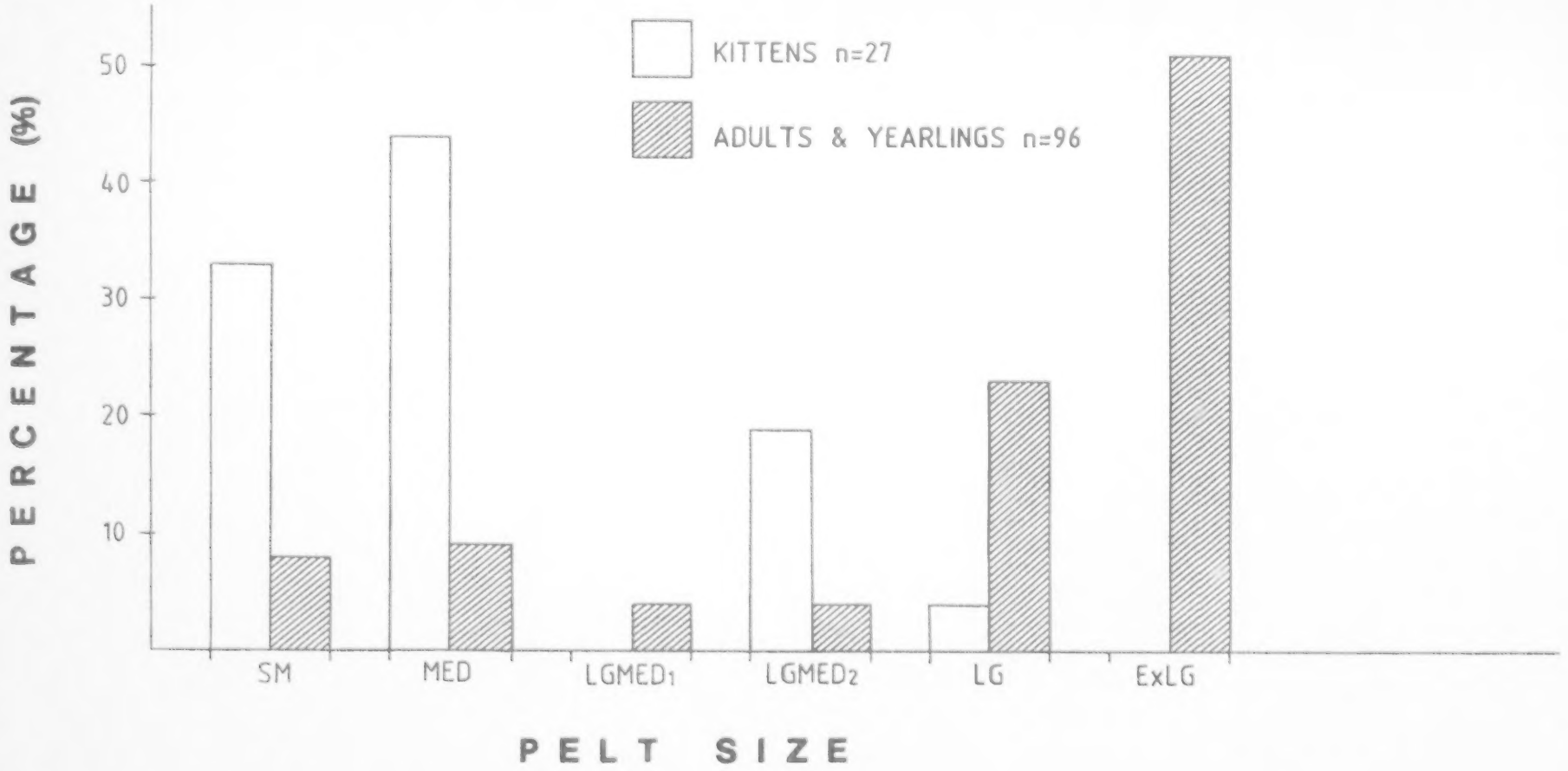


FIGURE 9. LYNX PELT SIZE* BY AGE CLASS, 1986/87 – 1988/89 DATA COMBINED

*Size descriptions as given in Table 13.



cutoff was used in this report.

There was an increase in the proportion of "kittens" in the Yukon sample from 6.6% in 1985/86 to 26.5% in 1988/89 (Table 13). The increased recruitment was evident in both the northern and southern zones, however the change occurred one season earlier in the northern subsample.

Table 13. Lynx Pelt Measurements, 1985/86 to 1988/89

%	Monitoring Zone											
	Southern				Northern				Yukon			
Pelt Size[1]	85/86	86/87	87/88	88/89	85/86	86/87	87/88	88/89	85/86	86/87	87/88	88/89
SM	1.4	2.6	8.8	5.9	4.0	1.9	7.4	9.4	2.2	2.8	9.4	9.0
MD	3.3	1.6	9.7	9.4	4.6	8.1	13.7	13.1	3.2	4.0	11.6	11.0
LGMED1(≤89cm)	1.4	2.1	5.0	6.3	-	2.5	4.2	6.8	1.2	1.9	4.5	6.5
ESTIMATED TOTAL ≤89	**6.1**	**6.3**	**23.5**	**21.6**	**8.6**	**12.5**	**25.3**	**29.3**	**6.6**	**8.7**	**25.5**	**26.5**
LGMED2(>89cm)	5.6	4.6	4.6	5.3	2.3	3.1	8.4	4.5	4.2	4.7	5.8	5.0
LG	31.1	34.0	20.6	22.9	24.7	29.2	25.3	33.2	28.8	30.8	22.8	27.7
EXLG	57.2	55.2	51.3	50.2	64.4	55.3	41.1	33.0	60.4	55.8	45.9	40.9
n	215	194	238	510	174	161	190	352	500	425	466	1069

1. SM, <81 x 20cm; MD, 81-86 x 22cm; LGMED1 86-89 x 23cm, LGMED2 >89-91 x 23cm, LG, 91-99 x 24cm; EXLG, >99 x 25cm.

Sex and Age Structure of the Lynx Harvest

Trappers that returned harvest calendars reported trapping almost twice as many males as females in 1986/87 and 1987/88 (Table 14). The bias towards males was not as pronounced in the carcass collection except in 1988/89. There is no obvious sex bias related to early or late season trapping, except in the 1987/88 harvest calendar sample (northern zone bias) and the 1988/89 carcass sample (all from southern zone) where the harvest favoured males in Nov-Dec in both cases.

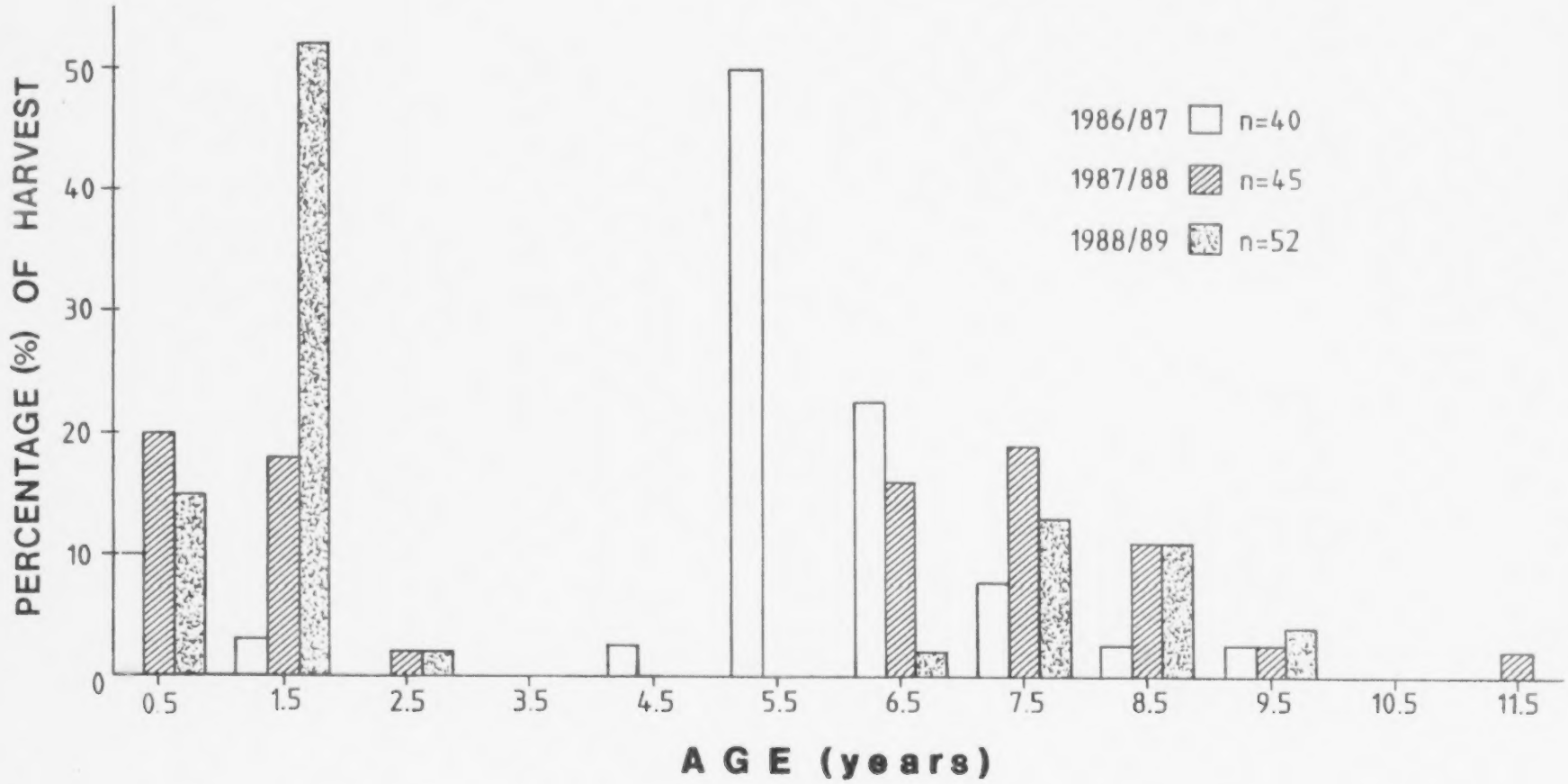
Table 14. Sex Ratio of Lynx Harvest

Data Source	Season	Males/100 Females (n)		
		Nov. - Dec.	Jan. - Feb.	Total
Harvest Calendars	1986/87	193 (34)	189 (26)	192 (60)
	1987/88	340 (44)	93 (29)	192 (73)
Carcass Collections	1986/87	50 (12)	90 (19)	72 (31)
	1987/88	100 (14)	89 (17)	94 (31)
	1988/89	300 (24)	108 (27)	168 (51)

Based on carcass collections, older age classes predominated in the harvest during the 1986/87 trapping season (Figure 10). The modal age of lynx trapped was 5.5 years with 50% of all lynx trapped falling into this age class. Eighty-five percent of all lynx trapped were 5.5 years of age or older. Kittens represented 10% of the harvest. There were no 2.5 or 3.5 year old lynx.

During the 1987/88 season, the age structure of the harvest had a bimodal distribution (Figure 10). Sixty percent of the harvest was composed of individuals 5.5 years of age or older. Thirty-eight percent of the harvest was kittens or yearlings. There were no lynx 3.5 - 5.5 years of age, inclusive in

FIGURE 10. AGE STRUCTURE OF LYNX HARVEST, 1986/87 – 1988/89



our harvest sample.

In 1988/89, the age structure of the harvest continued to shift to kitten and yearling age class (67%). Again there were no 3.5 - 5.5 year old lynx. The older cohorts (≥5.5 years) comprised only 31% of the harvest.

Data from the 1986/87 through 1988/89 trapping seasons were lumped to assess patterns in the age structure of the harvest throughout the season. The age structure of the harvest shifted from older to younger animals as the season progressed (Figure 11). Adults comprised 82% of the harvest in November and only 44% in February. No kittens were trapped in November while they comprised 22% of the harvest in February. Yearlings made up 18% of the harvest in November and 34% in February. Adults were harvested consistently throughout the season while the harvest of kittens and yearlings increased (Figure 12). Seventy-two percent of kittens and 75% of yearlings were harvested after December.

Body Condition of Harvested Lynx

Kidney fat was used as an index of body condition of lynx harvested (Table 15). Adults males were in better condition than adult females in 1986/87, and kitten males had significantly higher kidney fat weights than kitten females in 1987/88. Other comparisons of sexes within age classes and seasons were not significant. Adult female kidney fat weights were lower in 1987/88 than in the previous season. Adult kidney fat weights were significantly higher than kittens in all seasons, and yearlings in 1987/88 and 1988/89 (the 1986/87 sample size was too small). Yearlings had significantly higher kidney fat weights than kittens 1988/89.

FIGURE 11. AGE STRUCTURE OF LYNX HARVEST BY MONTH, 1986/87 – 1988/89 DATA COMBINED

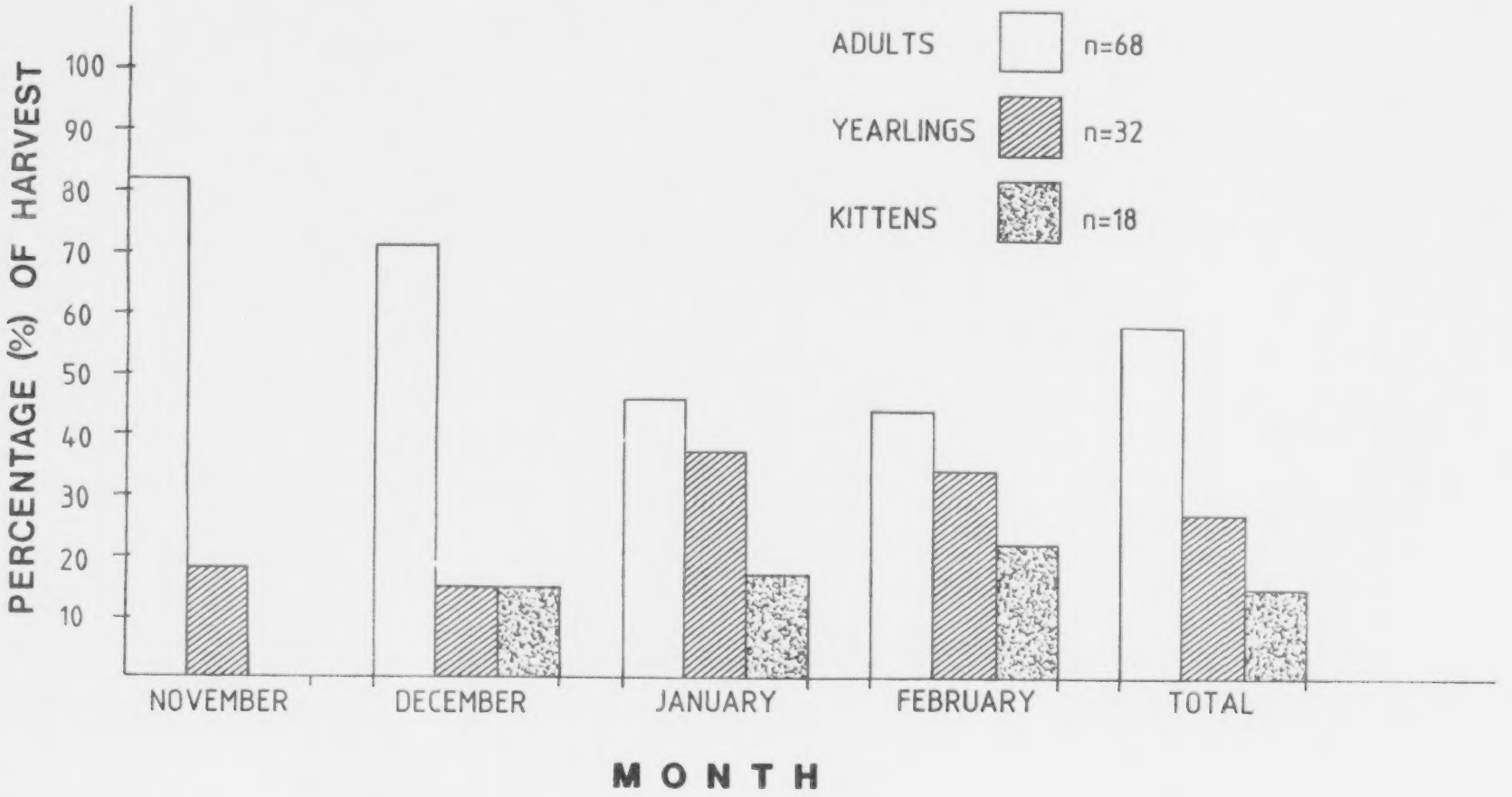


FIGURE 12. PROPORTION OF EACH AGE CLASS HARVESTED BY MONTH, 1986/87 – 1988/89 DATA COMBINED

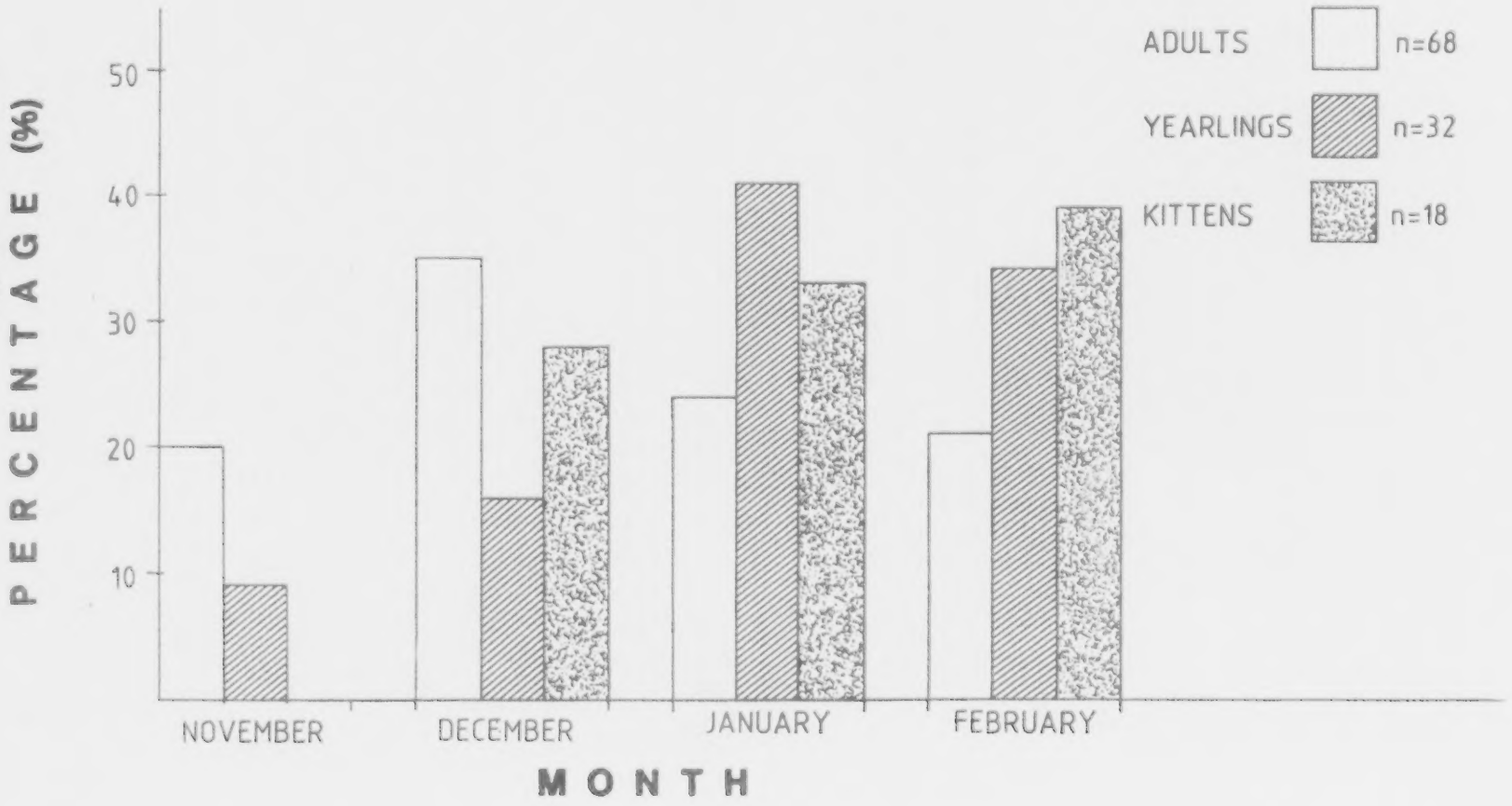


Table 15. Summary of Lynx Kidney Fat Weights.

		Season								
		1986/1987			1987/1988			1988/89		
Age	Sex	Mean (g)	SD	n	Mean (g)	SD	n	Mean (g)	SD	n
Adult	F	14.5	8.1	16	8.9	5.0	18	9.4	5.0	7
	M	24.61	15.8	15	13.9	7.3	10	11.0	9.7	10
	All	19.4	13.3	31	10.7	6.3	28	10.4	7.9	17
Kitten	F	3.6	5.1	2	0.86	0.88	5	0.87	0.64	3
	M	1.7	1.6	2	5.6	4.1	4	3.2	2.4	5
	All	2.6	3.3	4	3.0	3.6	9	2.3	2.2	8
Yearl.	F	4.7	--	1	6.8	8.2	3	5.1	3.7	9
	M	--	--	--	4.1	3.8	5	4.9	3.9	18
	All	--	--	7	5.2	5.4	8	5.0	3.8	27

Reproductive history of harvested female lynx

The reproductive history of female lynx in the harvest was determined by the presence and number of recent placental scars for females in our carcass collection. In utero litter sizes for adult female lynx tended to be higher in successive years although the differences were not statistically significant (Table 16). Mean in utero litter size for females that bred increased from 2.3 in 1986/87 to 3.8 in 1988/89. The adult pregnancy rate increased from 18% in 1986/87 to 72% in 1987/88. The pregnancy rate declined to 57% in 1988/89.

The first evidence of breeding by yearlings was in 1988/89, when 3 of 9 had placental scars.

Table 16. Summary of Lynx Pregnancy Rates and *in utero* Litter sizes.

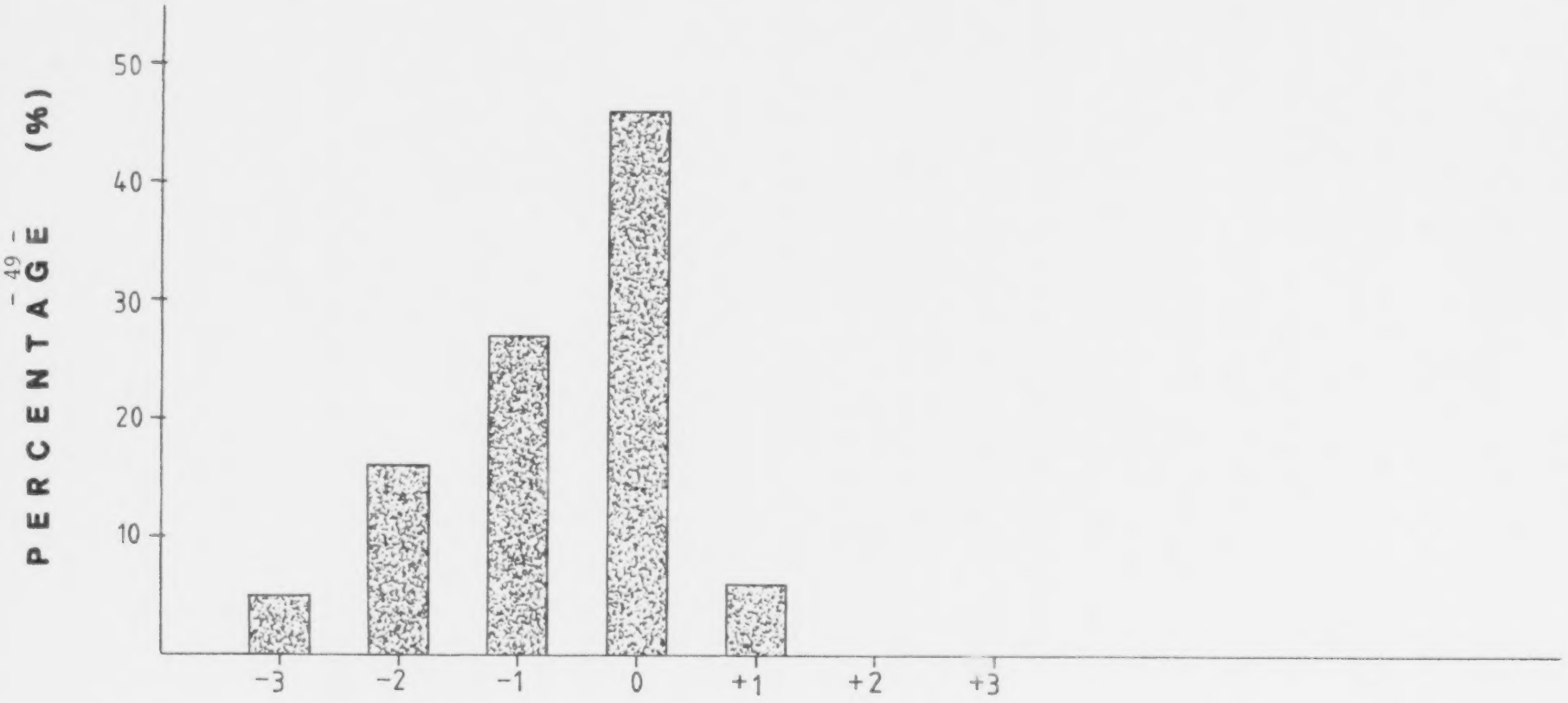
	1986/87				1987/88				1988/89			
Age	n	Percent with Placental Scars	Mean Number of Scars	SD	n	Percent with Placental Scars	Mean Number of Scars	SD	n	Percent with Placental Scars	Mean number of Scard	SD
Adults	17	18%	2.3	0.58	18	72%	3.5	1.4	7	57%	3.8	0.50
Yearl.	1	0	-	-	3	0	-	-	9	33%	2.7	1.20

Comparison of Using Canine and Incisor Teeth for Estimating Age

Canine teeth generally received better subjective ratings than incisors when aging with counts of cementum annuli. From the 1986/87 data (74 canines and 89 incisors), 57% of age estimates based on canine teeth were rated as good while only 18% based on incisors were rated as good. Forty-three percent of estimates based on incisors and canines received a fair rating. Thirty-nine percent of estimates based on incisors received a poor rating or were impossible to age due to the inability to distinguish annuli. No estimates based on canine teeth fell into the poor category.

An objective assessment of the data however, suggests that although canines may provide more accurate and reliable age estimates, incisors can also be used with fair degree of confidence. Forty-six percent of matched pairs (n=63, 1986/87 and 1987/88 data combined) of canines and incisors provided identical age estimates and 79% were within 1 year (Figure 13). There was a tendency to underestimate age using incisors (88% of discrepancies), particularly of older age classes ($\geq 5\frac{1}{2}$ years). The maximum discrepancies were -3 years (underestimates, n=3) and +1 year (overestimates, n=4).

FIGURE 13. LYNX INCISOR AGE ESTIMATE DIFFERENCE FROM CANINE AGE ESTIMATE



DISCUSSION

Snowshoe Hare Abundance

Annual increases in snowshoe hare abundance on our study area between 1987 and 1989, indicated by both spring hare turd counts and winter track counts, were concurrent with the regional hare population trend reported by trappers through the trapper questionnaire. Based on the questionnaire and on the findings of the long term snowshoe hare study at Kluane Lake (Boutin et al 1986), the last peak in hare abundance in SW Yukon ended in the fall of 1981. The subsequent population crash occurred in January 1982. The snowshoe hare densities recorded in the Snafu Lake study area during 1987 through 1989 averaged 0.7, 0.8, and 1.7 hares/ha respectively. Hare densities at the Kluane Lake study site ranged from 0.02/ha during the population low in 1977 to 2.1-3.5/ha during the peak phase in 1981 (Krebs et al 1986). Individual trapping grids had hare densities as high as 14.7/ha (Ward and Krebs 1985).

The high degree of variability in the number of turds counted per quadrat and in track-counts in all years both within and between habitat types reflects the patchy distribution of hares on the study area. Habitats with the densest shrub layers, such as 30 year old stands of pine/willow regeneration and regeneration mixed with unburned inclusions were the most heavily utilized. In 1987 and 1988, open habitats such as stands of white spruce/aspen and open stands of mature pine showed little or no signs of being utilized by hares. As the hare cycle progressed upwards, hare densities increased in the dense and open habitats alike. This pattern of utilization is similar to that described by Adams (1959), Keith and Windberg (1978), and Wolff (1980) for hares during the low and increasing phases of the cycle.

Lynx Abundance

Our trapping success (no. of lynx captures) and success rate (captures per 100tn), increased in each year of the study, reflecting an increase in lynx density. Minimum known lynx densities and estimated densities have also increased in each each year of the study. Our lynx densities of 3.1 to 9.0 lynx/100 km^2 are similar to population densities described by other researchers during low to intermediate hare abundance (Table 17). Brand et al (1976) found 2.3 to 6.9 lynx/100 km^2 on a study area in central Alberta, while hare were increasing from 0.8 to 1.85 hares/ha. Stephenson (1986) reported a range of densities between 1.8-5.7 lynx/100 km^2 on various portions of a study area in interior Alaska during the cyclic low. Reported lynx densities when hares were abundant were higher. Brand et al. (1976) reported 10.0 lynx/100 km^2 at high hare abundance on the same central Alberta study area mentioned above. Parker et al. (1983) estimated 20.0 lynx/100 km^2. Stephenson (1984a) interviewed trappers and reviewed harvest records to determine if there was a relationship between post-fire age of forests and productivity of hares and lynx. The "Teslin burn" of our study area (age 31 years) falls in the 15-50 year range he rates as the best lynx/hare habitat.

Recruitment from young born on the study area is not sufficient to explain this increase in lynx density. In March, 1987, we had 6 individuals radio-collared and suspected the presence of 2 additional animals on our study area. By March, 1988, we had collared 8 new individuals, only 1 of which had been born on the area during previous spring. Snow tracking indicated that 2 additional lynx kittens were reared on the area during 1987 but we were unsuccessful in live capturing them. During the winter of 1988/89 we live captured 10 new lynx on the area. Only 4 of these were young born on the area during the previous spring.

Table 17. Estimates of Lynx Density from Various Studies.

Density (Lynx/100km^2)	Population Status	Methods	Source
2.3	1966/67 low, Alberta	Tracks and Tracking	Brand et al 1976
10.0	1971/72 high, Alberta	Tracks and Tracking	Brand et al 1976
3.9-7.7	1964/65 and 1965/66 low, Newfoundland	experimental removal	Bergerud 1971
20.0	1978/79 low, Nova Scotia	Telemetry & Tracking	Parker et al 1983
5.6-13.0	1982/83 year following crash (high), Alaska	Telemetry & Tracking	Stephenson 1984b
5.4-6.1	1983/84 low, Alaska	Telemetry & Tracking	Stephenson and Karczmarczyk 1989
1.9	1987/88 low, with trapping, Alaska	Telemetry & Tracking	Stephenson and Karczmarczyk 1989
10.0-17.0	1973/74 peak, Kenai, Alaska	Fur Harvest	Bailey et al 1986
1-2.3	1977-82, Kenai, Alaska, low to peak, with heavy trapping	Harvest, Telemetry, & Tracking	Bailey et al 1986
2.4	1980-83 low, Washington	Telemetry & Tracking	Brittell et al 1989
5.1	1986/87 low, Kenai, Alaska	Telemetry & Tracking	Schwartz & Becker 1988
8.1	1984/85 Quebec, increasing harvest	Telemetry, Tracking, and extrapolation harvest age structure	Noiseux & Doucet 1987 Banville 1986

The origin of the 7 new lynx ($\geq$1½ years of age) during 1987/88 and 6 during 1988/89 is unknown. Two of the animals captured in 1987/88 may have been present at the start of the study but not captured during our first year. Based on snow tracking, the 11 others were certainly not present on the area since the start of the study and must have immigrated from surrounding areas.

This accounting suggests that at least 11 of the 24 lynx we have live captured have immigrated into our study area from elsewhere. Such a high degree of mobility supports our hypothesis that movements of individuals between areas may be important in stabilizing lynx populations over large geographic areas.

The trapper questionnaire lynx population level index reflected the increase in recruitment in the southern Yukon, around our study area, established from lynx pelt data and reproductive characteristics of female lynx (carcass data). The lynx harvest, however, did not track the apparent population increase. The harvest calendar data has shown that both the trapper effort and return per unit of trapper effort actually increased in 1987/88. There was no evidence of a lynx population decline, despite continued harvesting through the years of low recruitment. This supports our belief that the trapping concession (i.e. registered trapline) system, which limits trapping effort and promotes trapline management, combined with inaccessibility of concessions and the lack of use of many concessions, ensures the regular interspersion of refugia, which presumably conserves a population base and supplies a surplus to the active traplines.

Harvest calendar returns suggest that trappers were most successful during the first half of the season but put more effort into trapping during the last half of the season. This may be because they are not able to access their entire areas until after rivers and lakes freeze in late November and December. Trappers may also not be anxious to go out onto their lines during the short cold days of December. Alternatively, it may take a month or so for trappers to determine where the lynx are travelling and where they should set their traps.

Body Condition

The body weights and measurements of our live lynx were at the high end of the range of those reported in the literature (reviewed by Brittell et al 1989). They are close to the reported weights and measurements for Alaska lynx (Berrie 1969) during a snowshoe hare increase. A preponderance of older lynx found at

that time of the cycle, may bias the weights upwards, as most researchers class yearlings, which continue to grow until two years of age, as adults (Van Zyll de Jong 1963). The difference in size between sexes is believed to be due to faster male growth rate. The ultimate reason for sexual dimorphism in lynx is unclear, however.

Based on kidney fat weights of harvested lynx, adults were in significantly better shape than kittens and yearlings. Yearlings tended to have heavier kidney fat weights than kittens although the differences were not significant. This pattern is similar to that reported by other researchers. Brand and Keith (1979) and Parker et al. (1983) also found that adults tended to have more body fat than yearlings. The better body condition of adults is undoubtedly due to a combination of greater hunting skills and more years to accumulate fat reserves.

A significant difference in kidney fat weight between sexes was noted for adults in 1986/87 and kittens in 1987/88 with females being lighter than males. The difference in adult sex classes probably relates to the energetic stress of kitten rearing experienced by adult females. Brand and Keith (1979) also found adult males to have higher body fat indices than females while Parker et al. (1983) reported no significant difference between the sexes in any age class. The reason for the difference between condition of kitten sex classes is speculative, but may be due to faster fat accumulation by (larger) males, intra-litter competition, or favoritism by the mother.

Kidney fat weights within age classes and sexes differed between seasons only for adult females. Adult females had significantly heavier kidney fat weights

during 1986/87 than 1987/88. This result is surprising in light of the fact that hares were more abundant during 1987/88 than 1986/87. One possible explanation is that a higher proportion of females bred during 1987 than 1986. The added energetic stress of rearing young may have more than offset the increased food availability.

Sex Ratio

The sex structure of our live captured lynx sample has been biased towards males in each year of the study. We observed a similar bias towards males in the harvest calendar returns (1986/87, 1987/88) and in our carcass collection (1988/89). The carcass collection in 1986/87 favoured females and in 1987/88 tended towards equality.

Other researchers have also noted a bias towards males in the harvest (Van Zyll de Jong 1963, Berrie 1973, Quinn and Thomson 1985). It is generally suggested that the bias towards males in the harvest is because their large home ranges and greater mobility (of residents, transients and dispersing juveniles) make them more vulnerable by bringing them in contact with more traps.

Some researchers have also found equal sex ratios or ratios skewed towards females (Koontz 1976) as we did the 1986/87 carcass collection. Brand and Keith (1979) and Brittell (1989) found 1:1 sex ratios in their studies and Bailey et al. (1986) reported that females dominated the harvest in 4 of 7 years of their study. Quinn and Gardner (1984) suggested that, because of the apparently higher trapping vulnerability of males, an even sex ratio in the harvest or one skewed towards females might be indicative of overexploited lynx

populations. If this is the case, it is possible that our 1986/87 and 1987/88 carcass collections came from an overexploited population. The lynx harvest calendar returns were not from the carcass collection area, but were from known active and successful trappers in both the northern and southern zones. They did not indicate overharvest based on sex ratios.

Age Structure

The age structure of our annual live capture sample has shifted from being composed totally of adult age animals in the first year of the study (1986/87) to approximately 25% kittens during 1988/89. Based on our carcass collections, a similar shift toward younger animals also occurred in the Yukon lynx harvest. This almost certainly reflects higher pregnancy rates, larger litter sizes and better kitten survival rates with increasing snowshoe hare densities over the 3 years of the study.

Brand et al. (1976) also reported a positive correlation between the proportion of young in lynx populations and snowshoe hare abundance. They found no kittens on their study area during winters of low hare abundance. The proportion of kittens in their lynx population increased to 67% when hare abundance was increasing and 54% when hares were at their peak.

The fact that 85% of lynx in the 1986/87 harvest were 5.5 years or older indicates that they were born prior to the last crash in the snowshoe hare cycle in January, 1982. Only 5% of the 1986/87 harvest and 2% of the 1987/88 and 1988/89 harvests were born between 1982 and 1985. This undoubtedly reflects the poor recruitment rates into lynx populations during the period of low snowshoe hare abundance. It also underscores the importance of older aged

animals in maintaining lynx populations through the low and initiating the increase phase when hare numbers increase. Overharvesting these older aged animals during the low and early increase phases could drastically reduce the lynx populations ability to respond to increasing snowshoe hare abundance.

A preponderance of older aged individuals in the harvest, similar to that found from our carcass collections has been noted for lynx harvests during the low phase of the cycle when hares are scarce by several researchers (Brand and Keith 1979, Parker et al. 1983, O'Connor 1984). As recruitment into the lynx population increases with increasing snowshoe hare numbers, the proportion of kittens and yearlings in the harvest also increases (Berrie 1973, O'Connor 1984 and Quinn and Thompson 1987). We observed a dramatic shift in the age structure of the harvest towards younger individuals in our 1987/88 and 1988/89 carcass collections. The proportion of kittens and yearlings increased from 12.5% in 1986/87 to 67% during 1987/88. During periods of high hare abundance kittens and yearlings normally comprise 75% to 85% of the harvest (Brand and Keith 1979, Parker et al. 1983, O'Connor 1984).

Yearlings made up 18% of the 1987/88 and 52% of the 1988/89 harvest while kittens comprised only 10% and 20% of the 1986/87 harvest, respectively. This suggests that kittens are substantially under-represented in the harvest. Brand and Keith (1979) also reported that kittens were under represented in the harvest by 50% or more. They and Parker et al. (1983) suggested that this is likely due to some aspect of continuing maternal care of the kittens throughout most of their first winter. From snow tracking observations made on our study area, kittens did not begin to leave their mothers until late-March or April. Based on snow tracking and live-trapping, we believe that over 3 years of

study, we were successful in trapping 86.7% of 30 adults and 38.5% of 13 kittens present on our study area.

The age structure of the harvest shifted from older to younger aged animals as the season progressed. Based on carcass collection data, the proportion of kittens and yearlings in the monthly harvest totals increased as the season progressed. Yearlings comprised only 18% of the November harvest while they made up 34% of the February harvest. No kittens were trapped in November but they comprised 22% of the February harvest. These results are similar to our findings in live trapping lynx on our study area. All of our lynx kitten captures were made in March and April.

Parker et al. (1983) and Quinn and Thompson (1985) both found that the proportion of kittens in the harvest increased as the season progressed, similar to our findings. In contrast to our findings, however, they report that the proportion of yearlings in the harvest decreased later in the season. This trend towards yearlings being more strongly represented in the early season harvest is what one might intuitively expect. These naive, recently independent individuals would be relatively easily trapped and would therefore show up in the harvest early in the season. Why our findings do not follow this more intuitive pattern is unclear.

Recruitment

The in utero litter size of female lynx in our carcass collections increased, although not significantly between trapping seasons. This is undoubtedly due to the increase in snowshoe hare abundance and the resulting better body condition of lynx. The pregnancy rate also increased in 1987/88, but declined

in 1988/87 for adults, possibly an artifact of the small sample of adults, which comprised a smaller proportion of the harvested sample that year.

Other researchers have reported a strong positive correlation between snowshoe hare abundance and both lynx pregnancy rates and litters sizes (Brand and Keith 1979, Parker et al. 1983, O'Connor 1984). Based on their findings adult pregnancy rates can range from 33% during periods of hare scarcity to 76% when hares are abundance. Mean in utero litter size shows a concurrent increase from 3.4 to 4.9. Our adult pregnancy rates in 1987/88 and 1988/89 are near levels reported for intermediate to high hare abundances. The 1986/87 pregnancy rate of 18% is representative of a period of hare scarcity. Our mean in utero litter sizes of 2.3 to 3.8 are values normally reported for low hare abundances, however. The low litter sizes may reflect subtle differences in technique. Distinguishing placental scars from past year (recent) from those that are older is somewhat of an art. It is possible that we were more conservative than other researchers in our interpretation.

Yearling lynx reproductive rates tend to be even more strongly affected by hare abundance than adult rates. During periods of low hare abundance yearling pregnancy rates and in utero litter sizes are below 7% and 3.0 respectively. When hare are abundant pregnancy rates increase to as much as 69% and mean litter sizes of 4.2 have been reported (Brand and Keith 1979, Parker et al. 1983, O'Connor 1984).

The more extreme responses of yearlings to changes in hare abundance are probably related to nutrition. In order for lynx to breed as yearlings they must be sexually mature when they are ten months old. This rapid growth and

development undoubtedly requires the very high level of nutrition possible only when hares are abundant.

Our sample of live female lynx indicates a high pregnancy rate (90%) of adult females in all years (n=10). We did not document breeding by female kittens (n=2) and there have been no yearling females in the area to date. Litter sizes increased from 3-4 in 1987 and 1988 to 4-6 in 1989 concurrent with an increase in snowshoe hare abundance.

Litter sizes given in the literature are usually in utero and not post-parturition (Brand and Keith 1979). We did not find reference to litters of 6 as we observed in this study. Berrie (1973) reported a litter of 5 and Saunders (1963) and Brittell et al (1989) each found litters of two kits.

Emigration, Immigration, and Mortality

We have documented one natural adult mortality, one emigration (also a trapping mortality), 4 unconfirmed cases of emigration, and 13 possible cases of immigration, although 2 of the latter may have been original residents that weren't captured. Ward and Krebs (1985) documented 8 of 11 resident adult lynx which became transients when hare densities dropped below 0.5 hares/ha. These animals moved up to 700km before dying of starvation or being trapped. Many long distance movements have been documented (reviewed by Brittell et al 1989) by all age classes, following snowshoe hare declines. These animals may have been searching for pockets of abundant hares, or for vacant home ranges at all points of the cycle. Greater movements would be forced to occur when vacancies are fewer. Dispersers travel greater daily distances than residents (6.5-8.0km vs 2.1-3.0km, Stephenson 1986). Kittens typically leave their mother's range

in March (Saunders 1961, Bailey et al 1986, this study) or April (this study). European lynx siblings have been observed staying together for a short time after separation (Lindemann 1955, Guggisberg 1975). Emigration and immigration would have significant effects on resident populations when populations are low.

The causes of death of the kittens and one adult are unknown. The natural and trapping (dispersal) related mortality rates of adults are lower than previously shown in the literature. RMP Ward (in prep.) has shown that trapping mortality rates of previous studies averaged 55%, while natural mortality (of adults) was 3%. Kitten mortality during the low population phase in 1987 was similar to that estimated by Brand and Keith (1979) for the cyclic decline. The mortality rate for kittens dropped dramatically as hares began to increase in 1988.

Daily Travel Distances (DTD's)

Male DTD's were greater than female DTD's in 1987 and, seasonally, in May 1987 and March 1988. Such differences in DTD's have not been reported before. One would expect females to travel less when their litter is confined to a den (i.e. May-June) and that males would travel more during the breeding season, as we have observed in March-April. The DTD's observed during our study are much lower than those reported by Ward and Krebs (1985) for either low hare densities (5.3km/day) or high hare densities (2.7km/day). Their study was conducted during peak and declining hare densities when hares may have been more uniformly distributed than during the low and increasing phases of the study which we have observed. Ward and Krebs (1985) speculated that when good patches of prey are far apart, then it would be adaptive for lynx to seek out

and utilize those good patches. That would account for both the large DTD's observed by themselves and Saunders (1963) at low hare densities, and the low DTD's observed by ourselves. Track-counts and hare turd counts confirm that hare distribution was clumped, and that lynx were keying in on these clumps. Stephenson (1986) reported DTD's of 2.1-3.0km in Alaska 1982 (while dispersers moved 6.5-8.0km, similar to Nellis and Keith's (1968) observations of 1.6km (1966/67) and 2.9km (1965/66).

Home Range Size

The 95% home range areas reported are similar to home ranges reported for lynx foraging in similar hare densities (Ward and Krebs 1985, Brand et al 1976, Bailey et al 1986). Technical differences between methods of data collection and interpretation make such comparisons difficult. We believe that ground-based telemetry in irregular, rocky terrain (which altered signal directions), using too few (<60) data points, the inclusion of outliers or exploratory movements, using time periods which overlap different hare and lynx densities, may all add inaccuracies to home range analysis. We chose to base our analysis on annual snowshoe hare breeding cycles, and we excluded outliers and ground telemetry data.

Home range sizes did not differ between 1987 and 1988, even though hare and lynx densities increased. Home range overlap has been documented between females (Mech 1980,Carbyn and Patriquin 1983), males (Berrie 1973, Noiseaux and Doucet 1987) and animals of the opposite sex (Berrie 1973, Saunders 1963, Parker et al. 1983). Ward and Krebs (1985) and Brittell et al. (1989) found all 3 types of overlap during their studies. There would appear to be greater tolerance between animals of the opposite sex than there is for animals of the

same sex. Brittell et al. (1989) suggested, as Bailey (1974) did for bobcats, that different social systems may be used in different environments. Berrie (1973), who studied lynx during a similar phase of the hare cycle in Alaska, found a similar spatial organization to that found in the present study. During a hare decline in the Yukon, Ward and Krebs (1985) found the degree of overlap to be independent of hare density.

Techniques

Track Counts

Lynx track-counts depend not only on lynx density, but also on their movement patterns (daily cruising distances, home range size, and home range overlap) which are highly variable with snowshoe hare density and distribution. Table 18 summarizes the known lynx track-counts which have been conducted in conjunction with lynx and hare population studies. Although few data are available, they cover a wide range of lynx densities throughout the past 7 years in the Yukon and Alaska. There appears to be a relationship between lynx density and lynx track counts (although not significant with available data). The exception would appear to be when the use of hare population patches by lynx decrease the daily cruising distances and radii of lynx (proposed by Ward and Krebs 1985). We believe this occurred in our study durng 1987 and 1988. Track-counts still hold promise as a population monitoring technique when the hare population trend and status is concurrently monitored.

Pelt Measurements

Our preliminary data suggests that a pelt length of $\leq$89cm is an acceptable division between kitten and older lynx as found by Stephenson and Karczmarczyk (1989) for Alaska lynx and Poole (1989) for NWT lynx. The proportion of kittens between 81 and 89cm is much larger in the northwest than in Ontario, where Quinn and Gardner (1984) recommended <81cm for segregating the classes.

Fine-tuning this technique may be possible by using different cutoff points when kittens comprise a high proportion (e.g. $\geq$20%) of the harvest, or if it is found that kitten sizes vary greatly over the population cycle or even over the course of the trapping season.

Table 18. Lynx Track Counts in Relation to Lynx Density and the Snowshoe Hare Cycle

Lynx Track Counts (/100km-days)[1]	Lynx Density (/100km^2)	Hare Density and Stage of Cycle (/ha)	Authority
833.3	13.7 (MNA)[2]	14.7 to 9.5 Hare population crashing 1982	Ward (1985)
133.3	3.4	2.7 to 1.2 Hare population crashing 1982	Ward (1985)
183.3	3.4	1.8 Hare population crashing 1982	Ward (1985)
1.7 to 14.8	1.8 to 3.8	Population refugia during decline and low 1982-1987	Stephenson 1986 Stephenson & Karczmarczyk 1989
18.1	3.1	0.7 Population low 1987	This Study
18.8	6.3	0.8 Population increasing 1988	This Study
187.7	9.0	1.7 Population increasing 1989	This Study

1 Tracks/100km/day = (tracks/km of transect/day after snowfall) x 100
2 Minimum number alive

Comparison of using canine and incisor teeth for estimating age

Canines were the preferred tooth type for aging lynx, however they are very important to lynx in capturing and consuming their prey, and their loss would place a significant stress on the individual. In addition, canines are deeply rooted and would be extremely difficult to extract from live individuals. Incisors, on the other hand, are easily extracted in the field and the loss of one places a relatively minor stress on the individual. This, together with the fact that 79% of age estimates based on incisors were within one year of those based on canines means that they are an acceptable substitute when trying to age live captured individuals.

Management Implications

The increase phase of the lynx population cycle has typically been characterized by increases in lynx reproductive rates and kitten survival. Changes in lynx behaviour during a population increase have not previously been studied, as they have for declining or stable (fringe) populations. Our study is demonstrating the significance of movements (dispersal) to the lynxes' ability to locate and exploit an increasing, although still patchy snowshoe hare population. This is similar to their behaviour during a snowshoe hare decline when hare distribution may also be patchy.

Without refuge from trapping, dispersing lynx are extremely vulnerable to trapping, and full exploitation of hare patches by lynx (i.e. the achievement of carrying capacity populations) may not be possible. In addition, the lynx recruited before the hare crash are responsible for initiating the increase phase when hare numbers increase. Refugia from trapping thus serve as lynx production centres which, we hypothesize, disperse outward into adjacent areas and incidentally supply traplines. The best are hare population refugia (patches). Trapping traditional areas year after year, rather than shifting trapping locations, would maintain the long-term benefits of refugia, including the optimization of productivity.

The optimal size and spatial distribution of refugia, with reference to the supply of emigrants to active traplines, requires additional study.

Recommendations

1. Maintain the trapping concession system for granting the exclusive right to trap specific areas. The system promotes self management, which may include use of the "tracking strategy" of harvesting and the maintenance of trapping refugia. It also limits trapper density (trapping effort) and facilitates area-specific harvest, questionnaire, and biological data collection.
2. Maintain the projects for lynx population and harvest monitoring, including lynx pelt sealing, trapper questionnaire, and track counts.
3. Identify lynx population refugia and work with trappers to ensure protection from trapping during cyclic lows.
4. Continue present study at least 3 years beyond the hare crash, to obtain data for all stages of the lynx cycle and better document the dynamics of lynx refugia.

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